PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-192318

(43)Date of publication of application : 09.07.2003

(51)Int.Cl. C01B 31/02

(21)Application number : 2001-389180

(22)Date of filing : 21.12.2001

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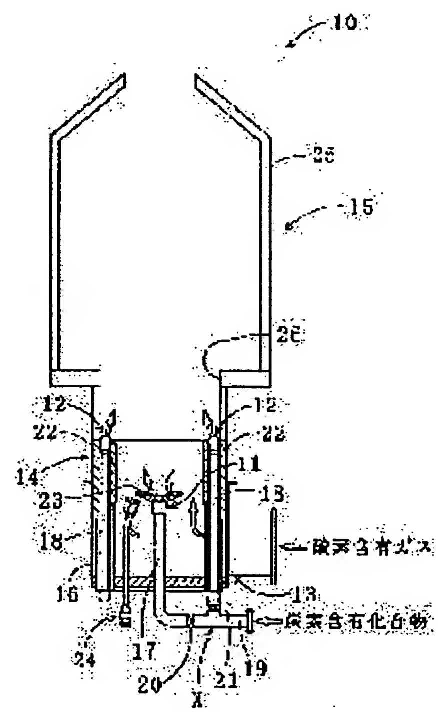
(54) MANUFACTURING APPARATUS FOR FULLERENE AND METHOD OF MANUFACTURING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a manufacturing apparatus and a method of manufacturing fullerene in large quantity, expensively and easily by controlling a precursor of the fullerene and a residence time of the fullerene in a fullerene producing region.

SOLUTION: The fullerene manufacturing apparatus 10 is composed of a reaction furnace 15 provided with a burner part 14 having carbon containing compound feeding ports 11, 12, and an oxygen containing gas feeding port 13, wherein raw materials of the carbon containing compound and the oxygen containing gas are burned so as to manufacture the fullerene, and the carbon containing compound feeding ports 11, 12 are formed in a multistage state. The method of manufacturing the fullerene by burning the carbon containing compound and the oxygen containing gas at a pressure lower than the atmospheric pressure, the carbon containing compound is fed in multistage feeding.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

(19)日本国特許庁（JP）　(12) **公開特許公報**（A）

(11)特許出願公開番号
特開2003－192318
(P2003－192318A)
(43)公開日　平成15年7月9日(2003.7.9)

(51)Int.Cl.⁷	識別記号	FI	テーマコード(参考)
C01B 31/02	101	C01B 31/02	101F　4G046

審査請求　未請求　請求項の数11　OL　(全9頁)

(21)出願番号　特願2001－389180(P2001－389180)

(22)出願日　平成13年12月21日(2001.12.21)

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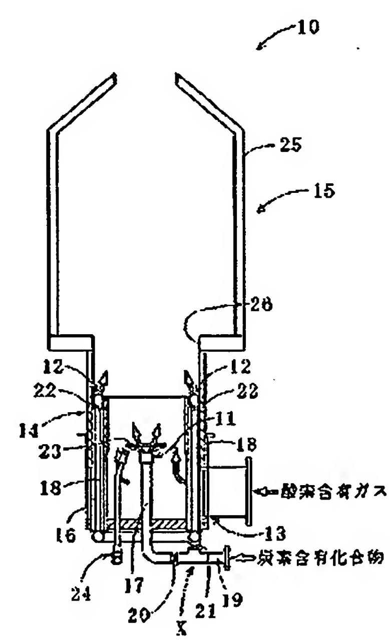
Fターム(参考)　4G046 CA01 CA05 CC02 CC03 CC09

(54)【発明の名称】　フラーレンの製造装置及びその製造方法

(57)【要約】

【課題】　フラーレンの生成領域におけるフラーレン前駆体及びフラーレンの滞留時間を制御し、フラーレンを大量に且つ安価に、そして容易に製造可能なフラーレンの製造装置及びその製造方法を提供する。

【解決手段】　炭素含有化合物供給口11、12と酸素含有ガス供給口13とを有する燃焼用バーナー部14を備える反応炉15で、原料となる炭素含有化合物と酸素含有ガスとを燃焼させてフラーレンを製造する製造装置10であって、炭素含有化合物供給口11、12を多段に備える。その製造方法は、原料となる炭素含有化合物と酸素含有ガスとを大気圧未満で燃焼させてフラーレンを製造する方法において、炭素含有化合物を多段に供給する。



【特許請求の範囲】

【請求項１】　炭素含有化合物供給口と酸素含有ガス供給口とを有する燃焼用バーナー部を備える反応炉で、原料となる炭素含有化合物と酸素含有ガスとを燃焼させてフラーレンを製造する製造装置であって、前記炭素含有化合物供給口及び酸素含有ガス供給口を多段に備えることを特徴とするフラーレンの製造装置。

【請求項２】　炭素含有化合物供給口と酸素含有ガス供給口とを有する燃焼用バーナー部を備える反応炉で、原料となる炭素含有化合物と酸素含有ガスとを燃焼させてフラーレンを製造する製造装置であって、前記炭素含有化合物供給口を多段に備えることを特徴とするフラーレンの製造装置。

【請求項３】　炭素含有化合物供給口と酸素含有ガス供給口とを有する燃焼用バーナー部を備える反応炉で、原料となる炭素含有化合物と酸素含有ガスとを燃焼させてフラーレンを製造する製造装置であって、前記酸素含有ガス供給口を多段に備えることを特徴とするフラーレンの製造装置。

【請求項４】　請求項１～３のいずれか１項に記載のフラーレンの製造装置において、前記燃焼用バーナー部の最上流部に完全燃焼帯を設けることを特徴とするフラーレンの製造装置。

【請求項５】　原料となる炭素含有化合物と酸素含有ガスとを大気圧未満で燃焼させて、フラーレンを製造する方法において、前記炭素含有化合物及び酸素含有ガスを、それぞれ多段に供給することを特徴とするフラーレンの製造方法。

【請求項６】　原料となる炭素含有化合物と酸素含有ガスとを大気圧未満で燃焼させて、フラーレンを製造する方法において、前記炭素含有化合物を多段に供給することを特徴とするフラーレンの製造方法。

【請求項７】　原料となる炭素含有化合物と酸素含有ガスとを大気圧未満で燃焼させて、フラーレンを製造する方法において、前記酸素含有ガスを多段に供給することを特徴とするフラーレンの製造方法。

【請求項８】　請求項５～７のいずれか１項に記載のフラーレンの製造方法において、前記フラーレンの生成を１０～５００ｔｏｒｒで行うことを特徴とするフラーレンの製造方法。

【請求項９】　請求項５～８のいずれか１項に記載のフラーレンの製造方法において、少なくとも前記フラーレンの生成領域のガス流を層流とすることを特徴とするフラーレンの製造方法。

【請求項１０】　請求項５～９のいずれか１項に記載のフラーレンの製造方法において、前記酸素含有ガス中には、０又は０を超え９０モル％以下の不活性ガスが含まれていることを特徴とするフラーレンの製造方法。

【請求項１１】　請求項５～１０のいずれか１項に記載のフラーレンの製造方法において、前記フラーレンの生成領域の温度を６００～２３００℃の範囲とすることを特徴とするフラーレンの製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、フラーレン（例えば、C_{60}、C_{70}等）を製造可能なフラーレンの製造装置及びその製造方法に関する。

【０００２】

【従来の技術】フラーレン（以下、フラーレン類とも言う）は、ダイヤモンド、黒鉛に次ぐ第三の炭素同素体の総称であり、C_{60}、C_{70}などに代表されるように、５員環と６員環のネットワークで閉じた中空殻状の炭素分子である。このフラーレンの存在が最終的に確認されたのは比較的最近の１９９０年のことであり、比較的新しい炭素材料であるが、その特殊な分子構造ゆえに特異的な物理的性質を示すことが認められ、例えば以下のような広範囲の分野に渡り、革新的な用途開発が急速に展開されつつある。

（１）超硬材料への応用

フラーレンを前駆体とすることで、微細結晶粒子をもつ人工ダイヤモンドの製造が可能となるため、付加価値のある耐摩耗材料への利用が期待されている。

（２）医薬品への応用

C_{60}誘導体及び光デバイスを用いることで、例えば、抗癌剤、エイズ、骨粗鬆症、アルツハイマー治療薬、造影剤、ステント材料等の用途としての研究が進められている。

（３）超伝導材料への応用

フラーレン薄膜に金属カリウムをドープすることで、１８Ｋという高い転移温度を持つ超伝導材料を製造できることが発見され、多方面から注目を集めている。

（４）半導体製造への応用

レジストにC_{60}を混ぜることで、レジスト構造がより一層強化されることを利用し、次世代半導体の製造への応用が期待されている。このようにフラーレンは、次世代を担う新材料、新素材として多方面から注目されている。なお、各種炭素数を有するフラーレンの中でも、C_{60}及びC_{70}は比較的合成が容易であり、それゆえ今後の需要も爆発的に高まることが予想されている。

【０００３】また、現在知られているフラーレンの製造方法としては、以下に示す方法が挙げられる。

（１）レーザー蒸着法：希ガス中に置かれた炭素ターゲットに高エネルギー密度のパルスレーザーを照射し、炭素原子の蒸発により合成する方法。まず、希ガスが流れる石英管を電気炉の中に置き、グラファイト試料をその石英管の中に置く。そして、ガスの流れの上流側からグラファイト試料にレーザーを照射し蒸発させることで、電気炉出口付近の冷えた石英管の内壁にC_{60}やC_{70}などのフラーレンを含む煤（すす）を付着させる。なお、このレーザー蒸着法は、グラファイト試料のレーザーショ

ット当たりの蒸発量が僅かであるため、大量製造には不向きである。
（２）抵抗加熱法：ヘリウムガスで満たされた真空の容器の中でグラファイト棒を通電加熱し昇華させる方法。なお、この抵抗加熱法は、回路における電気抵抗ロスが大きいため、大量製造に不向きである。
（３）アーク放電法：数十ｋＰａ中のヘリウムガス中で２本のグラファイト電極を軽く接触させたり、あるいは１～２ｍｍ程度離した状態でアーク放電を起こし、陽極の炭素を昇華させる方法。このアーク放電法は、現在工場規模での大量製造に用いられている。
（４）高周波誘導加熱法：抵抗加熱やアーク放電を使う代わりに、高周波誘導によりグラファイト原料に過電流を流し、グラファイト原料を加熱し蒸発させる方法。
（５）燃焼法：ヘリウム等の不活性ガスと酸素との混合ガス中でベンゼン等の炭化水素原料を不完全燃焼させる方法。この燃焼法を用いた場合、ベンゼン燃料の数％が煤となり、その１０％程度がフラーレンとなるため、製造効率は良くない。しかし、複製する煤（フラーレン等）を液体燃料等に使用可能な点、また製造装置が単純である点で、アーク放電法に対抗する大量生産法として注目されている。
（６）ナフタレン熱分解法：ナフタレンを約１０００℃で熱分解させる方法。
【０００４】上記したように、現在までさまざまなフラーレンの合成法が提案されているが、いずれの方法によってもこれまでにフラーレンを安価に、しかも大量に製造する方法は確立されていなかった。しかし、上記した方法の中において、燃焼法は、フラーレンの大量生産に向き、またフラーレンの合成域における最高温度が１７００℃程度と他の方法と比べて比較的低温であり、他の方法に比べて容易に製造することができる。例えば、特表平６－５０７８７９号公報には、炭素含有化合物（炭化水素原料）を火炎中で燃焼させ凝縮物を収集するフラーレンの製造方法が提案されている。
【０００５】
【発明が解決しようとする課題】しかしながら、上記した燃焼法によるフラーレンの製造方法には以下の問題がある。フラーレンはすす状物質中に含まれて生成するが、燃焼法ではすす状物質中に含まれるフラーレンの割合が低いため経済的でない。そこで、このフラーレンの生成割合をいかに高めるかが大きな課題となっている。また、一般的に、閉じられた容器の中に火炎を形成させると、火炎中心部と火炎以外の部分で流速差が生じ、燃焼反応が活発に行われる火炎中心部の流速が速くなる。このため、火炎外周部で上流からの燃焼ガスの逆流及び巻き込みが起こり、自己循環が発生する場合が多い。このような排ガスの自己循環は、火炎温度の局所的高温化を防ぎ、ＮＯｘの発生を抑制する効果がある一方、フラーレンの生成過程（生成領域）において滞留時間の不均一化をもたらす。つまり、自己循環が発生すると、火炎中でフラーレンが生成している段階において、この循環ガスの流れにのったフラーレン前駆体は滞留時間が長くなり、一方、循環ガスの流れにのらないフラーレン前駆体は滞留時間が短くなる。従って、フラーレンの収率を悪くし、組成が不均一となる。本発明はかかる事情に鑑みてなされたもので、フラーレンの生成領域におけるフラーレン前駆体及びフラーレンの滞留時間を制御し、フラーレンを大量に且つ安価に、そして容易に製造可能なフラーレンの製造装置及びその製造方法を提供することを目的とする。
【０００６】
【課題を解決するための手段】前記目的に沿う第１の発明に係るフラーレンの製造装置は、炭素含有化合物供給口と酸素含有ガス供給口とを有する燃焼用バーナー部を備える反応炉で、原料となる炭素含有化合物と酸素含有ガスとを燃焼させてフラーレンを製造する製造装置であって、炭素含有化合物供給口及び酸素含有ガス供給口を多段に備える。このように構成することで、炭素含有化合物と酸素含有ガスとを、それぞれ分割して供給できるので、炭素含有化合物と酸素含有ガスとの燃焼時における急激な体積膨張を抑制できる。前記目的に沿う第２の発明に係るフラーレンの製造装置は、炭素含有化合物供給口と酸素含有ガス供給口とを有する燃焼用バーナー部を備える反応炉で、原料となる炭素含有化合物と酸素含有ガスとを燃焼させてフラーレンを製造する製造装置であって、炭素含有化合物供給口を多段に備える。このように構成することで、燃焼用バーナー部においては、炭素含有化合物を、酸素含有ガスに対して希薄な低当量比から徐々に供給することができる。前記目的に沿う第３の発明に係るフラーレンの製造装置は、炭素含有化合物供給口と酸素含有ガス供給口とを有する燃焼用バーナー部を備える反応炉で、原料となる炭素含有化合物と酸素含有ガスとを燃焼させてフラーレンを製造する製造装置であって、酸素含有ガス供給口を多段に備える。このように構成することで、燃焼用バーナー部においては、酸素含有ガスを、炭素含有化合物に対して希薄な低当量比から徐々に供給することができる。ここで、第１～第３の発明に係るフラーレンの製造装置において、燃焼用バーナー部の最上流部に完全燃焼帯を設けることが好ましい。これにより、燃焼用バーナー部の最上流部において、炭素含有化合物と酸素含有ガスとを完全燃焼させることができる。
【０００７】前記目的に沿う第１の発明に係るフラーレンの製造方法は、原料となる炭素含有化合物と酸素含有ガスとを大気圧未満で燃焼させて、フラーレンを製造する方法において、炭素含有化合物及び酸素含有ガスをそれぞれ多段に供給する。これにより、炭素含有化合物と酸素含有ガスとの燃焼を分割して行うことができるので、炭素含有化合物と酸素含有ガスとの燃焼時における

急激な体積膨張を抑制できる。前記目的に沿う第２の発明に係るフラーレンの製造方法は、原料となる炭素含有化合物と酸素含有ガスとを大気圧未満で燃焼させて、フラーレンを製造する方法において、炭素含有化合物を多段に供給する。これにより、燃焼用バーナー部においては、炭素含有化合物を、酸素含有ガスに対して希薄な低当量比から徐々に供給し、燃焼させることができる。前記目的に沿う第３の発明に係るフラーレンの製造方法は、原料となる炭素含有化合物と酸素含有ガスとを大気圧未満で燃焼させて、フラーレンを製造する方法において、酸素含有ガスを多段に供給する。これにより、燃焼用バーナー部においては、酸素含有ガスを、炭素含有化合物に対して希薄な低当量比から徐々に供給し、燃焼させることができる。

【０００８】ここで、第１～第３の発明に係るフラーレンの製造方法において、フラーレンの生成を１０～５００ｔｏｒｒで行うことが好ましい。第１～第３の発明に係るフラーレンの製造方法において、少なくともフラーレンの生成領域のガス流を層流とすることが好ましい。第１～第３の発明に係るフラーレンの製造方法において、酸素含有ガス中には、０又は０を超え９０モル％以下の不活性ガスが含まれていることが好ましい。第１～第３の発明に係るフラーレンの製造方法において、フラーレンの生成領域の温度を６００～２３００℃の範囲とすることが好ましい。

【０００９】

【発明の実施の形態】続いて、添付した図面を参照しつつ、本発明を具体化した実施の形態につき説明し、本発明の理解に供する。ここに、図１は本発明の第１の実施の形態に係るフラーレンの製造装置の説明図、図２は本発明の第２の実施の形態に係るフラーレンの製造装置の説明図、図３は本発明の第３の実施の形態に係るフラーレンの製造装置の説明図である。

【００１０】図１に示すように、本発明の第１の実施の形態に係るフラーレンの製造装置１０は、炭素含有化合物供給口１１、１２と酸素含有ガス供給口１３とを有する燃焼用バーナー部１４を備える反応炉１５で、原料となる炭素含有化合物と酸素含有ガスとを使用し、炭素含有化合物を燃焼（不完全燃焼）させてフラーレンを製造する装置である。以下、詳しく説明する。

【００１１】反応炉１５の下側（上流側）に設けられた燃焼用バーナー部１４は、上部が開口した円筒状のケーシング１６と、このケーシング１６の中央部及び内側周辺部にそれぞれ炭素含有化合物を供給するための配管１７、１８とを備えている。この配管１７、１８は、炭素含有化合物が供給される配管１９を分岐して設けたものであり、この分岐点Ｘより下流側の配管１７、１８には、それぞれバルブ２０、２１が設けられ、各配管１７、１８を流れる炭素含有化合物の供給量を調整できるようになっている。なお、ケーシング１６の内側周辺部に取付けられた配管１８は、等間隔に多数備えられ、しかもこの配管１８の中央部から上端にかけての周囲には、断熱壁２２が取付けられている。また、中央部に設けられた配管１７の高さは、ケーシング１６の内側周辺部に設けられた配管１８の高さの半分程度となっており、各配管１７、１８の上端部には、炭素含有化合物供給口１１、１２がそれぞれ設けられている。なお、中央部に設けられた配管１７の炭素含有化合物供給口１１にはスタビライザー２３が取付けられ、このスタビライザー２３の側方にはパイロットバーナー２４が配置されている。このスタビライザー２３により、炭素含有化合物供給口１１の上方に形成される炎の形状を安定化させている。

【００１２】ケーシング１６の下側側部には、酸素含有ガス供給口１３が設けられ、燃焼用バーナー部１４の下側（上流側）から上側（下流側）へかけて、酸素含有ガスを供給可能な構成となっている。このように、燃焼用バーナー部１４においては、炭素含有化合物供給口１１、１２が、形成される高温ガス流の流れ方向、即ち酸素含有ガスの流れ方向に対して多段（この実施の形態においては２段）に備えられている。従って、炭素含有化合物を、酸素含有ガスに対して希薄な低当量比から徐々に供給することができる。

【００１３】反応炉１５の上側には、ケーシング１６の上端に一体的に取付けられ、上部が徐々に縮径して開口した略円筒状の反応部２５が備えられている。この反応部２５の上端には、反応部２５で生成したフラーレンを下流側に流すための配管（図示しない）が接続されている。一方、反応部２５の底部には、ケーシング１６の内径と径を同じとする開口部２６が設けられ、燃焼用バーナー部１４から発生した燃焼流が、この開口部２６を介して反応部２５へ流れる。なお、上記した反応炉１５には、真空手段の一例である真空ポンプ（図示しない）が接続され、反応炉１５内の圧力を大気圧未満としている。

【００１４】このように構成することで、配管１７から供給する炭素含有化合物を、酸素含有ガス供給口１３から供給される酸素含有ガスの一部で完全燃焼させ、更に配管１８から供給する炭素含有化合物を、残りの酸素含有ガスで完全燃焼又は不完全燃焼させる。ここで、配管１８からの炭素含有化合物の供給量が、残りの酸素含有ガスの当量と略同等量である場合、炭素含有化合物が完全燃焼するので、反応部２５の底部及び／又は側壁部に供給口を設け、炭素含有化合物を供給することが好ましい。これにより、燃焼用バーナー部１４で発生した燃焼流によって、供給した炭素含有化合物を熱分解させてフラーレンを生成できる。一方、配管１８からの炭素含有化合物の供給量が、残りの酸素含有ガスの当量より過剰である場合、燃焼用バーナー部１４において炭素含有化合物が不完全燃焼するので、フラーレンが生成する。従

って、反応部２５に炭素含有化合物を供給するための供給口を設ける必要はないが、設けてもよい。なお、燃焼用バーナー部１４の最上流部を含む、燃焼用バーナー部１４の全体又は上部（下流側端部）を除く全体が、完全燃焼帯を構成することとなる。

【００１５】続いて、本発明の第１の実施の形態に係るフラーレンの製造方法について、フラーレンの製造装置１０を用いて説明する。まず、酸素含有ガス供給口１３から酸素含有ガスを供給すると共に、燃料となる炭素含有化合物を炭素含有化合物供給口１１へ配管１７を介して供給し、パイロットバーナー２４を用いて火炎を形成する。更に、配管１７からの供給に加えて、配管１８から燃料（燃料及び原料）となる炭素含有化合物を供給することで、炭素含有化合物を、形成される高温ガス流の流れ方向、即ち酸素含有ガスの流れ方向に対して２段に供給する。なお、供給される酸素含有ガスは、配管１７及び配管１８から供給される炭素含有化合物を完全燃焼させるために必要な当量と同等又は当量より少ない量である。従って、配管１７から供給される炭素含有化合物の量は、配管１７及び配管１８から供給される炭素含有化合物を完全燃焼させるために必要な、酸素含有ガスの当量の２０～７０％程度とすることが好ましい。なお、配管１８から供給される炭素含有化合物は、この炭素含有化合物を完全燃焼させるために必要な残りの酸素含有ガスの当量と、同等又はより過剰な量である。

【００１６】ここで、炭素含有化合物としては任意のものを使用でき、例えば、水素、一酸化炭素、天然ガス、石油ガス等の燃料ガス、重油等の石油系液体燃料、クレオソート油等の石油系液体燃料等、メタン、エタン、プロパン、エチレン、プロピレン等の直鎖又は分岐鎖を有する脂肪族飽和もしくは不飽和炭化水素、ベンゼン、トルエン、ｏ－キシレン、ｍ－キシレン、ｐ－キシレン、ナフタレン、アントラセン等の芳香族（系）炭化水素等やこれらの混合物等が挙げられる。中でも精製した芳香族炭化水素が好ましく、特にベンゼンやトルエン等の芳香族炭化水素を用いることが好ましい。なお、原料の純度は高い方が好ましく、中でも芳香族炭化水素を用いる場合には、その純度が１００％に近いほど良い。

【００１７】また、酸素含有ガスとしては、純酸素（酸素含有ガス中の不活性ガス量が０％のもの）や、０を超え９０モル％以下の不活性ガス（例えば、ヘリウムガス、アルゴンガス）を含むガスを使用することが好ましい。ここで、酸素含有ガス中の不活性ガスの量が多いほど、反応炉内の雰囲気を酸素が希薄な状態とし、均一な品質を備えたフラーレンを製造できるが、不活性ガスの量が９０モル％を超えた場合、フラーレンの製造に必要な熱エネルギーを造り出すための酸素量が確保できない。なお、不活性ガスは、供給用の専用ノズルから供給しても良いし、また炭素含有化合物及び／又は酸素含有ガス中に予め混合させておくことも可能である。

【００１８】なお、反応部２５内（反応炉１５内）の圧力は、生成するフラーレンの生成効率を高めるため、大気圧未満、即ち１０～５００ｔｏｒｒ、好ましくは５０～４００ｔｏｒｒ、更には１００～４００ｔｏｒｒとすることが好ましい。また、炭素含有化合物を酸素含有ガスに対して多段に供給するので、少なくともフラーレンの生成領域、即ち反応部２５内のガス流は層流（例えば、１０～１００ｃｍ／ｓｅｃ程度）となる。なお、燃焼用バーナー部１４のガス流は、乱流となってもよいが、反応部２５への影響を考慮すれば、層流となることが好ましい。そして、炭素含有化合物を均一に気化させ反応（熱分解）させるためには、フラーレンの生成領域、即ち反応部２５内の温度を十分高温雰囲気とすることが好ましく、反応部２５内の平均温度を６００～２３００℃、好ましくは１０００～２０００℃、更には１２００～１８００℃の範囲とすることが好ましい。この条件のもと、原料となる炭素含有化合物を燃焼（不完全燃焼）させ、反応炉１５で粗フラーレンを生成させる。

【００１９】反応炉１５で生成した粗フラーレン（例えば、C_{60}やC_{70}、及びこれ以上の分子量を有する高次フラーレン等を含んだフラーレン）とその他の煤成分とは、分離部にて燃焼ガスから分離される。そして、従来公知の溶媒抽出法や昇華法等により、フラーレンと他の煤成分とを分離すればよい。なお、燃焼法にて生成させる際、温度調整することで、フラーレンを気体状態とし、その他の煤成分を固体状態として、分離部にてフラーレンをその他の煤成分と分離してもよい。このためには、分離部に入る粗フラーレンの温度を３００℃以上とすることが必要である。なお、３００℃未満では、生成したフラーレンが一部固体状態となって分離部を通過できないため、回収量が減少する可能性がある。一方、温度が高すぎると、分離部の劣化を促進したり、またフラーレン以外の煤成分の一部が分離部を通過し、回収したフラーレン中に混入してしまう可能性がある。このため、粗フラーレンの温度を、３００～２３００℃、更には３００～１５００℃とすることが好ましい。

【００２０】次に、本発明の第２の実施の形態に係るフラーレンの製造装置３０について説明するが、反応炉３１の反応部２５は、本発明の第１の実施の形態に係るフラーレンの製造装置１０と同一のものであるため、同一の番号を付し詳しい説明を省略する。図２に示すように、本発明の第２の実施の形態に係るフラーレンの製造装置３０は、炭素含有化合物供給口３２と酸素含有ガス供給口３３、３４とを有する燃焼用バーナー部３５を備える反応炉３１で、原料となる炭素含有化合物と酸素含有ガスとを使用し、炭素含有化合物を燃焼（不完全燃焼）させてフラーレンを製造する装置である。

【００２１】反応炉３１の下側（上流側）に設けられた燃焼用バーナー部３５は、上部が開口した円筒状のケーシング３６を備えている。このケーシング３６の底部に

は貫通孔３７が設けられ、ケーシング３６の下方（上流側）には、貫通孔３７と軸心を同一とする筒状の突出部３８が備えられている。そして、この突出部３８の内部には、突出部３８の軸心に沿って炭素含有化合物を供給するための配管３９が配置されている。この配管３９の上部は、貫通孔３７を貫通し、ケーシング３６側へ僅かに突出しており、この配管３９の上端に、炭素含有化合物供給口３２が設けられている。なお、突出部３８の側部には、酸素含有ガス供給口３３が設けられている。また、ケーシング３６の下側側部にも、酸素含有ガス供給口３４が設けられ、ケーシング３６の中央部には、貫通孔３７の軸心に沿って筒状の分離壁４０が配置され、この分離壁４０の下端がケーシング３６の底に取付けられている。これにより、突出部３７から供給された酸素含有ガスを、ケーシング３６から供給された酸素含有ガスと接触させることなく、炭素含有化合物供給口３２に供給することができる。

【００２２】そして、この分離壁４０の上端には、ケーシング３６の下側と上側を区分する分離盤４１が取付けられている。この分離盤４１の中央部には、開口部４２が設けられ、また分離盤４１の周辺部には、同一円周上に等間隔に設けられた複数の貫通孔４３が設けられている。これにより、酸素含有ガス供給口３４から供給された酸素含有ガスが、ケーシング３６の上側で残った炭素含有化合物と反応可能となっている。このように、燃焼用バーナー部３５においては、酸素含有ガス供給口３３、３４が、形成される高温ガス流の流れ方向、即ち炭素含有化合物の流れ方向に対して多段（この実施の形態においては２段）に備えられている。従って、酸素含有ガスを、炭素含有化合物に対して希薄な低当量比から徐々に供給することができる。

【００２３】このように構成することで、炭素含有化合物供給口３２から供給される炭素含有化合物の一部を、突出部３８から供給した酸素含有ガスで完全燃焼させ、更に残りの炭素含有化合物を完全燃焼させるために必要な当量と同等又はそれより少ない酸素含有ガスをケーシング３６の下側から供給し、炭素含有化合物を完全燃焼又は不完全燃焼させる。ここで、ケーシング３６の下側から供給される酸素含有ガスの供給量が、残りの炭素含有化合物の当量と略同等量である場合、炭素含有化合物が完全燃焼するので、反応部２５の底部及び／又は側壁部に供給口を設け、炭素含有化合物を供給することが好ましい。これにより、燃焼用バーナー部３５で発生した燃焼流によって、供給した炭素含有化合物を熱分解させてフラーレンを生成できる。一方、ケーシング３６の下側から供給される酸素含有ガスの供給量が、残りの炭素含有化合物の当量より少ない場合、燃焼用バーナー部３５において炭素含有化合物が不完全燃焼するので、フラーレンが生成する。従って、反応部２５に炭素含有化合物を供給するための供給口を設ける必要はないが、設けてもよい。なお、燃焼用バーナー部３５の最上流部を含む、燃焼用バーナー部３５の全体又は上部（下流側端部）を除く全体が、完全燃焼帯を構成することとなる。

【００２４】続いて、本発明の第２の実施の形態に係るフラーレンの製造方法について、フラーレンの製造装置３０を用いて説明するが、燃焼バーナー部３５の燃焼方法以外は、本発明の第１の実施の形態に係るフラーレンの製造方法と同じであるため、燃焼バーナー部３５の燃焼方法についてのみ説明する。まず、燃料（燃料及び原料）となる炭素含有化合物を炭素含有化合物供給口３２へ配管３９を介して供給すると共に、突出部３８の酸素含有ガス供給口３３から酸素含有ガスを供給し、火炎を形成する。このとき、酸素含有ガスの供給量は、供給される炭素含有化合物を完全燃焼させるために必要な量より少ない（例えば、炭素含有化合物を完全燃焼させるために必要な当量の２０～７０％程度）。更に、ケーシング３６の下側の酸素含有ガス供給口３４から酸素含有ガスを供給することで、炭素含有ガスを、形成される高温ガス流の流れ方向、即ち炭素含有化合物の流れ方向に対して２段に供給する。この供給量は、残りの炭素含有化合物を完全燃焼させるために必要な当量と同等又は当量より少ない量である。そして、反応部２５内（反応炉３１内）の圧力、ガス流、及び温度を、前記した条件に設定し、原料となる炭素含有化合物を不完全燃焼させ、フラーレンを生成させる。

【００２５】本発明の第３の実施の形態に係るフラーレンの製造装置５０について説明するが、このフラーレンの製造装置５０を用いたフラーレンの製造方法は、本発明の第１の実施の形態に係るフラーレンの製造方法と略同じであるため、説明を省略する。図３に示すように、本発明の第３の実施の形態に係るフラーレンの製造装置５０は、炭素含有化合物供給口５１、５２と酸素含有ガス供給口５３とを有する燃焼用バーナー部５４を備える反応炉５５で、原料となる炭素含有化合物と酸素含有ガスとを使用し、炭素含有化合物を燃焼（不完全燃焼）させてフラーレンを製造する装置である。以下、詳しく説明する。

【００２６】反応炉５５の上側には、上部が徐々に縮径して開口した略円筒状の反応部５６が備えられている。この反応部５６の上端には、反応部５６で生成したフラーレンを下流側に流すための配管（図示しない）が接続されている。一方、反応部５６の下端には、反応部５６より僅かに小さい径を備え、酸素含有ガスを供給するための配管５７が一体的に取付けられている。また、この配管５７の内部には、炭素含有化合物を供給する配管５８から分岐した配管５９が組み込まれ、この配管５９を更に分岐させた後、分岐した配管６０の上端（下流側）を反応部５６の下端に一体的に取付けている。なお、分岐後の複数の配管６０の分岐点より下流側には、各配管６０からの炭素含有化合物の供給量をそれぞれ調整可能

とするバルブ６１が取付けられている。

【００２７】そして、反応部５６の下側側部、即ち反応部５６の高さの例えば１／４～１／２程度の位置には、炭素含有化合物を供給するための炭素含有化合物供給口５１が設けられている。この炭素含有化合物供給口５１は、反応部５６の周囲に反応部５６の軸心に対して等角度に複数設けられることが好ましい。ここで、配管５８から分岐した配管６２が炭素含有化合物供給口５１に取付けられることで、反応部５６内へ炭素含有化合物を供給可能としている。この配管６２にもバルブ６３が取付けられ、炭素含有化合物の供給量を調整可能としている。なお、反応部５６の底部には、複数の貫通孔が設けられ、この貫通孔が、炭素含有化合物供給口５２と酸素含有ガス供給口５３とを構成している。ここで、この複数の貫通孔の形状は任意であり、平面視して実質的に円形、楕円形、矩形、多角形等や、ひょうたん型の不定形であってもよい。また、貫通孔の配置位置は任意であるが、反応部５６へ燃焼流を均一に流すため、反応部５６の軸心を中心とした同一又は同心円周上に等間隔で、複数の貫通孔を配置することが好ましい。この際、貫通孔の開口端部は、反応部５６の底面と略同一平面上にあっても、また突出していてもよく、貫通孔の個数は任意である。ここで、燃焼用バーナー部５４は、上記した配管５７～６０、配管６２も有している。

【００２８】このように、燃焼用バーナー部５４においては、炭素含有化合物供給口５１、５２が、形成される高温ガス流の流れ方向、即ち酸素含有ガスの流れ方向に対して多段（この実施の形態においては２段）に備えられている。従って、炭素含有化合物を、酸素含有ガスに対して希薄な低当量比から徐々に供給することができる。なお、ここでは、炭素含有化合物供給口を多段に設けることで、炭素含有化合物を多段に供給した場合について説明したが、炭素含有化合物と酸素含有ガスの供給口を取替えて、酸素含有ガス供給口を多段に設けることで、酸素含有ガスを多段に供給してもよい。上記した反応部５６には、真空手段の一例である真空ポンプ（図示しない）が接続され、反応部５６内の圧力を大気圧未満としている。

【００２９】以上、本発明を、実施の形態を参照して説明してきたが、本発明は何ら上記した実施の形態に記載の構成に限定されるものではなく、特許請求の範囲に記載されている事項の範囲内で考えられるその他の実施の形態や変形例も含むものである。例えば、前記実施の形態においては、炭素含有化合物供給口又は酸素含有ガス供給口を、形成される高温ガス流のガスの流れ方向に対してそれぞれ２段備えた場合について説明した。しかし、炭素含有化合物供給口又は酸素含有ガス供給口を、３段以上備えることも可能であり、更に、炭素含有化合物供給口及び酸素含有ガス供給口を、それぞれ２段以上備えることも可能である。また、炭素含有化合物供給口及び／又は酸素含有ガス供給口を任意の位置に配置して、多段に備えることも可能である。

【００３０】また、前記第１、第２の実施の形態においては、反応炉の下側に設けられた燃焼用バーナー部を１台取付けた場合について説明した。しかし、複数の燃焼用バーナー部を反応炉の下側に設けることも可能である。この場合、反応部の底部には、燃焼用バーナー部の取付け部分に対応する位置に開口部をそれぞれ形成することが好ましい。これにより、炭素含有化合物と酸素含有ガスとの燃焼時における急激な体積膨張を更に抑制できる。そして、前記実施の形態においては、炭素含有化合物が燃焼、例えば不完全燃焼させフラーレンを生成させた場合について説明したが、完全燃焼させた場合でも、フラーレンが生成する場合もある。

【００３１】

【発明の効果】請求項１～４記載のフラーレンの製造装置、請求項５～１１記載のフラーレンの製造方法においては、炭素含有化合物及び／又は酸素含有ガスを分割して供給できるので、炭素含有化合物と酸素含有ガスとの燃焼時における急激な体積膨張を抑制できる。従って、炭素含有化合物と酸素含有ガスとを一度に供給して燃焼させた場合と比較し、フラーレンの生成領域におけるフラーレン前駆体及びフラーレンの滞留時間を長くできるので、フラーレンを大量に且つ安価に、そして容易に製造できる。

【００３２】請求項２及びこれに従属する請求項４記載のフラーレンの製造装置、請求項６及びこれに従属する請求項８～１１記載のフラーレンの製造方法においては、燃焼用バーナー部で、炭素含有化合物を、酸素含有ガスに対して希薄な低当量比から徐々に供給することができる。従って、炭素含有化合物の低当量比によるＮＯｘ排出量の低減効果に加え、高濃度炭素含有化合物による窒素酸化物還元反応時におけるＮＯｘ低減を図ることができるので、例えば反応炉内に大気が混入した場合においても、大気汚染の可能性を低減できる。

【００３３】請求項３及びこれに従属する請求項４記載のフラーレンの製造装置、請求項７及びこれに従属する請求項８～１１記載のフラーレンの製造方法においては、燃焼用バーナー部で、酸素含有ガスを、炭素含有化合物に対して希薄な低当量比から徐々に供給することができる。従って、火炎内部に高温領域が形成されるのを極力抑制し、ＮＯｘの低減を図ることができるので、例えば反応炉内に大気が混入した場合においても、大気汚染の可能性を低減できる。特に、請求項４記載のフラーレンの製造装置においては、燃焼用バーナー部の最上流部において、炭素含有化合物と酸素含有ガスとを完全燃焼させることができる。従って、燃焼用バーナー部の最上流部における炭素含有化合物と酸素含有ガスとの反応効率が高められるので、フラーレンの生成を経済的に行うことができる。

【００３４】請求項８記載のフラーレンの製造方法においては、フラーレンの生成を１０～５００ｔｏｒｒの圧力下で行うので、フラーレンの生成効率を高めることができる。請求項９記載のフラーレンの製造方法においては、フラーレンの生成領域のガス流を層流とするので、フラーレンの生成領域におけるフラーレン前駆体及びフラーレンの滞留時間を更に長くでき、フラーレンの生成効率を高めることができる。請求項１０記載のフラーレンの製造方法においては、フラーレンの生成を希薄な酸素状態の下で行うので、フラーレンの生成領域の温度分布を均一にし、安定した品質のフラーレンを製造できる。請求項１１記載のフラーレンの製造方法においては、フラーレンの生成領域の温度を６００～２３００℃の高温にすることで、炭素含有化合物を均一に気化させ反応させて、安定した品質のフラーレンを製造できる。

【図面の簡単な説明】

【図１】本発明の第１の実施の形態に係るフラーレンの製造装置の説明図である。

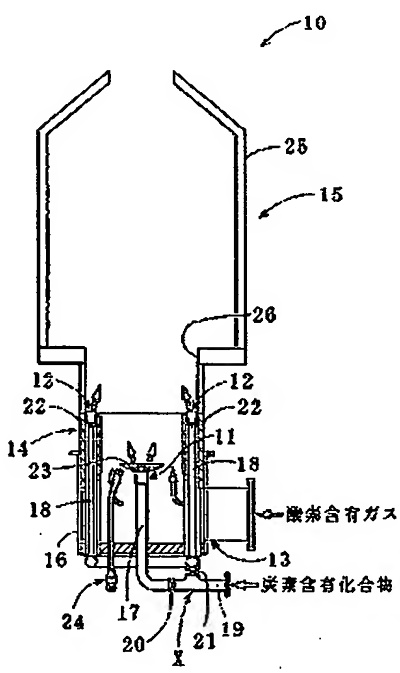
【図２】本発明の第２の実施の形態に係るフラーレンの＊＊製造装置の説明図である。

【図３】本発明の第３の実施の形態に係るフラーレンの製造装置の説明図である。

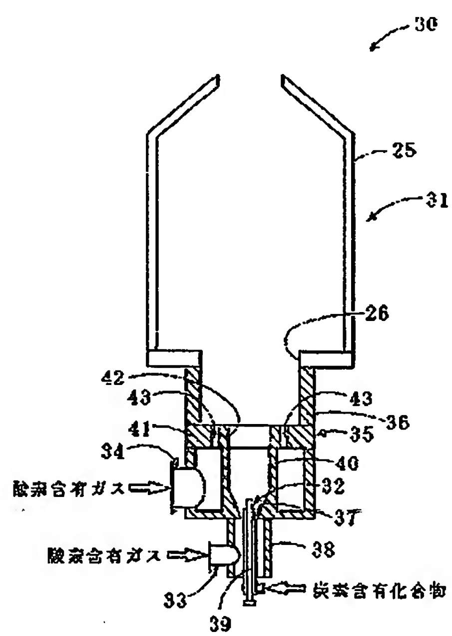
【符号の説明】

１０：フラーレンの製造装置、１１、１２：炭素含有化合物供給口、１３：酸素含有ガス供給口、１４：燃焼用バーナー部、１５：反応炉、１６：ケーシング、１７～１９：配管、２０、２１：バルブ、２２：断熱壁、２３：スタビライザー、２４：パイロットバーナー、２５：反応部、２６：開口部、３０：フラーレンの製造装置、３１：反応炉、３２：炭素含有化合物供給口、３３、３４：酸素含有ガス供給口、３５：燃焼用バーナー部、３６：ケーシング、３７：貫通孔、３８：突出部、３９：配管、４０：分離壁、４１：分散盤、４２：開口部、４３：貫通孔、５０：フラーレンの製造装置、５１、５２：炭素含有化合物供給口、５３：酸素含有ガス供給口、５４：燃焼用バーナー部、５５：反応炉、５６：反応部、５７～６０：配管、６１：バルブ、６２：配管、６３：バルブ

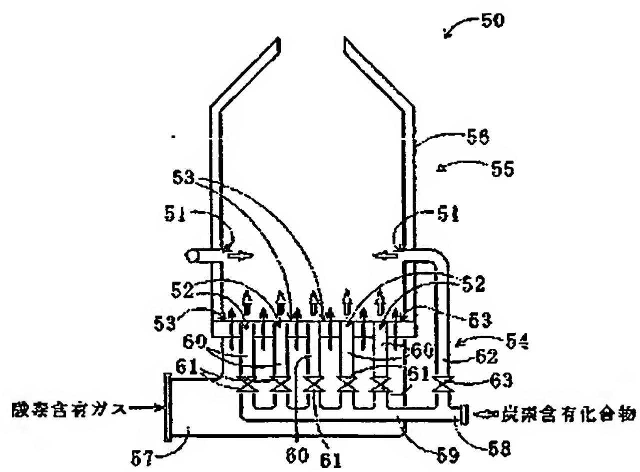
【図１】



【図２】



【図3】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酸素含有ガス
炭素含有化合物
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CLAIMS

[Claim(s)]
[Claim 1] The manufacturing installation of the fullerene characterized by being the manufacturing installation which the carbon content compound and oxygen content gas used as a raw material are burned, and manufactures fullerene with a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, and equipping multistage with said carbon content compound feed hopper and oxygen content gas supply opening.
[Claim 2] The manufacturing installation of the fullerene characterized by being the manufacturing installation which the carbon content compound and oxygen content gas used as a raw material are burned, and manufactures fullerene with a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, and equipping multistage with said carbon content compound feed hopper.
[Claim 3] The manufacturing installation of the fullerene characterized by being the manufacturing installation which the carbon content compound and oxygen content gas used as a raw material are burned, and manufactures fullerene with a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, and equipping multistage with said oxygen content gas supply opening.
[Claim 4] The manufacturing installation of the fullerene characterized by forming a perfect combustion band in the maximum upstream section of said burner section for combustion in the manufacturing installation of fullerene given in any 1 term of claims 1-3.
[Claim 5] The manufacture approach of the fullerene characterized by supplying said carbon content compound and oxygen content gas to multistage, respectively in the approach of burning the carbon content compound and oxygen content gas used as a raw material under in atmospheric pressure, and manufacturing fullerene.
[Claim 6] The manufacture approach of the fullerene characterized by supplying said carbon content compound to multistage in the approach of burning the carbon content compound and oxygen content gas used as a raw material under in atmospheric pressure, and manufacturing fullerene.
[Claim 7] The manufacture approach of the fullerene characterized by supplying said oxygen content gas to multistage in the approach of burning the carbon content compound and oxygen content gas used as a raw material under in atmospheric pressure, and manufacturing fullerene.
[Claim 8] The manufacture approach of the fullerene characterized by generating said fullerene by 10 - 500torr in the manufacture approach of fullerene given in any 1 term of claims 5-7.
[Claim 9] The manufacture approach of the fullerene characterized by making the gas stream of the generation field of said fullerene into a laminar flow at least in the manufacture approach of fullerene given in any 1 term of claims 5-8.
[Claim 10] The manufacture approach of the fullerene characterized by exceeding 0 or 0 and containing the inert gas not more than 90 mol % in said oxygen content gas in the manufacture approach of fullerene given in any 1 term of claims 5-9.

[Claim 11] The manufacture approach of the fullerene characterized by making temperature of the generation field of said fullerene into the range of 600-2300 degrees C in the manufacture approach of fullerene given in any 1 term of claims 5-10.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacturing installation and its manufacture approach of the fullerene which can manufacture fullerene (for example, C60, C70 grade).
[0002]
[Description of the Prior Art] Fullerene (henceforth fullerene) is the generic name of the third carbon allotrope which ranks second to a diamond and a graphite, and as represented in C60, C70, etc., it is the carbon molecule of the shape of hollow husks closed in the network of five membered-rings and six membered-rings. Although it is comparatively that existence of this fullerene was finally checked and it is a comparatively new carbon material, it is admitted that that special molecular structure, therefore specific physical property are shown, for example, innovative application development is being quickly developed over the wide range following fields.
(1) Since manufacture of an artificial diamond with a fine crystal grain child is attained by using application fullerene to a superhard ingredient as a precursor, use to an abrasion resistance material with added value is expected.
(2) By using application C60 derivative and the optical device to drugs, research as an application of an anticancer agent, an acquired immunode-ficiency syndrome, osteoporosis, the Alzheimer remedy, a contrast medium, a stent ingredient, etc. is advanced.
(3) It is discovered that the superconducting material which has a high transition temperature called 18K with doping metallic potassium in the application fullerene thin film to a superconducting material can be manufactured, and since various, attract attention.
(4) By mixing C60 with the application resist to semi-conductor manufacture, it uses that resist structure is strengthened further and the application to manufacture of a next-generation semi-conductor is expected. Thus, since fullerene is various as the exotic material which bears the next generation, and new materials, it attracts attention. In addition, C60 and C70 are comparatively easy to compound also in the fullerene which has various carbon numbers, and it is expected that future need so also increases explosively.
[0003] Moreover, the approach shown below is mentioned as the manufacture approach of fullerene learned now.
(1) Laser vacuum deposition : how to irradiate the pulse laser of a high energy consistency at the carbon target placed into rare gas, and compound by evaporation of a carbon atom. First, the quartz tube with which rare gas flows is placed into an electric furnace, and a graphite sample is placed into the quartz tube. And the soot (soot) containing fullerene, such as C60 and C70, is made to adhere to the wall of the quartz tube with which near the electric furnace outlet got cold by irradiating laser and evaporating it in a graphite sample, from the upstream of the flow of gas. In addition, since this laser vacuum deposition has the slight evaporation per laser shot of a graphite sample, it is unsuitable for extensive manufacture.
(2) Resistance heating method : the approach to which carry out energization heating and a graphite rod is made to sublimate in the container of the vacuum filled with gaseous helium. In addition, since this

resistance heating method has the large electric resistance loss in a circuit, it is unsuitable for extensive manufacture.
(3) Arc discharge method : the approach to which the carbon of a lifting and an anode plate is made to sublimate arc discharge in the condition of having contacted two graphite electrodes lightly in the gaseous helium in dozens kPa(s), or having detached about 1-2mm. This arc discharge method is used for extensive manufacture on a current works scale.
(4) Radio frequency heating method : how to heat a sink and a graphite raw material in a graphite raw material by RF induction, and to evaporate an eddy current instead of using resistance heating and arc discharge.
(5) Combustion method : the approach of carrying out the incomplete combustion of the hydrocarbon raw materials, such as benzene, in the mixed gas of inert gas, such as helium, and oxygen. Since several% of a benzene fuel serves as soot and those about 10% becomes fullerene when this combustion method is used, manufacture effectiveness is not good. However, the soot (fullerene etc.) to reproduce is observed as the mass-producing method for opposing an arc discharge method at the point usable to liquid fuel etc., and the point that a manufacturing installation is simple.
(6) Naphthalene thermal decomposition method : the approach of carrying out the pyrolysis of the naphthalene at about 1000 degrees C.
[0004] Although the synthesis method of various fullerene to current was proposed as described above, the method of manufacturing fullerene cheaply and in large quantities by any approach until now was not established. However, toward mass production method of fullerene, the maximum temperature in the synthetic region of fullerene is low temperature comparatively compared with about 1700 degrees C and other approaches, and can manufacture [be / it / under / of the above-mentioned approach / setting] a combustion method easily compared with other approaches. For example, the manufacture approach of the fullerene which a carbon content compound (hydrocarbon raw material) is burned in a flame in the Patent Publication Heisei No. 507879 [six to] official report, and collects condensates in it is proposed.
[0005]
[Problem(s) to be Solved by the Invention] However, there are the following problems in the manufacture approach of the fullerene by the above-mentioned combustion method. Although it is contained in the soot-like matter and generated, since the rate of fullerene of the fullerene contained in the soot-like matter in a combustion method is low, it is not economical. Then, it has been a big technical problem how the generation rate of this fullerene is raised. Moreover, if a flame is made to form into the closed container generally, the rate-of-flow difference will arise in parts other than a flame core and a flame, and the rate of flow of the flame core where a combustion reaction is performed actively will become quick. For this reason, a back flow and contamination of the combustion gas from the upstream happen in the flame periphery section, and self-circulation occurs in many cases. Such self-circulation of exhaust gas prevents local elevated-temperature-ization of flame temperature, and while there is effectiveness which controls generating of NOx, it brings about ununiformity-ization of the residence time in the generation process (generation field) of fullerene. That is, as for the fullerene precursor with which, as for the fullerene precursor which rode the flow of this circulating gas in the phase which fullerene is generating in the flame, the residence time does not ride the flow of circulating gas on the other hand by becoming long, the residence time will become short if self-circulation occurs. Therefore, yield of fullerene is worsened and a presentation serves as an ununiformity. This invention was made in view of this situation, and controls the residence time of the fullerene precursor in the generation field of fullerene, and fullerene, and it aims at offering the manufacturing installation and its manufacture approach of the fullerene which can be manufactured cheaply and easily in large quantities [fullerene].
[0006]
[Means for Solving the Problem] The manufacturing installation of the fullerene concerning the 1st invention in alignment with said purpose is a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, is a manufacturing installation which the carbon content compound and oxygen content gas used as a

raw material are burned, and manufactures fullerene, and equips multistage with a carbon content compound feed hopper and oxygen content gas supply opening. Thus, since a carbon content compound and oxygen content gas are divided, respectively and can be supplied with constituting, a rapid cubical expansion at the time of combustion with a carbon content compound and oxygen content gas can be controlled. The manufacturing installation of the fullerene concerning the 2nd invention in alignment with said purpose is a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, is a manufacturing installation which the carbon content compound and oxygen content gas used as a raw material are burned, and manufactures fullerene, and equips multistage with a carbon content compound feed hopper. Thus, with constituting, a carbon content compound can be gradually supplied from thin low equivalent ratio to oxygen content gas in the burner section for combustion. The manufacturing installation of the fullerene concerning the 3rd invention in alignment with said purpose is a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, is a manufacturing installation which the carbon content compound and oxygen content gas used as a raw material are burned, and manufactures fullerene, and equips multistage with oxygen content gas supply opening. Thus, with constituting, oxygen content gas can be gradually supplied from thin low equivalent ratio to a carbon content compound in the burner section for combustion. Here, in the manufacturing installation of the fullerene concerning the 1st - the 3rd invention, it is desirable to form a perfect combustion band in the maximum upstream section of the burner section for combustion. Thereby, in the maximum upstream section of the burner section for combustion, the perfect combustion of a carbon content compound and the oxygen content gas can be carried out.

[0007] The manufacture approach of the fullerene concerning the 1st invention in alignment with said purpose burns the carbon content compound and oxygen content gas used as a raw material under in atmospheric pressure, and supplies a carbon content compound and oxygen content gas to multistage in the approach of manufacturing fullerene, respectively. Since combustion with a carbon content compound and oxygen content gas can be divided and can be performed by this, a rapid cubical expansion at the time of combustion with a carbon content compound and oxygen content gas can be controlled. The manufacture approach of the fullerene concerning the 2nd invention in alignment with said purpose burns the carbon content compound and oxygen content gas used as a raw material under in atmospheric pressure, and supplies a carbon content compound to multistage in the approach of manufacturing fullerene. Thereby, in the burner section for combustion, to oxygen content gas, a carbon content compound can be supplied gradually and can be burned from thin low equivalent ratio. The manufacture approach of the fullerene concerning the 3rd invention in alignment with said purpose burns the carbon content compound and oxygen content gas used as a raw material under in atmospheric pressure, and supplies oxygen content gas to multistage in the approach of manufacturing fullerene. Thereby, in the burner section for combustion, to a carbon content compound, oxygen content gas can be supplied gradually and can be burned from thin low equivalent ratio.

[0008] Here, in the manufacture approach of the fullerene concerning the 1st - the 3rd invention, it is desirable to generate fullerene by 10 - 500torr. In the manufacture approach of the fullerene concerning the 1st - the 3rd invention, it is desirable to make the gas stream of the generation field of fullerene into a laminar flow at least. In the manufacture approach of the fullerene concerning the 1st - the 3rd invention, it is desirable that exceed 0 or 0 and the inert gas not more than 90 mol % is contained in oxygen content gas. In the manufacture approach of the fullerene concerning the 1st - the 3rd invention, it is desirable to make temperature of the generation field of fullerene into the range of 600-2300 degrees C.

[0009]

[Embodiment of the Invention] Then, referring to the attached drawing, it explains per gestalt of the operation which materialized this invention, and an understanding of this invention is presented. The explanatory view of the manufacturing installation of the fullerene which drawing 1 requires for the gestalt of operation of the 1st of this invention here, the explanatory view of the manufacturing

installation of the fullerene which drawing 2 requires for the gestalt of operation of the 2nd of this invention, and drawing 3 are the explanatory views of the manufacturing installation of the fullerene concerning the gestalt of operation of the 3rd of this invention.

[0010] The manufacturing installation 10 of the fullerene which starts the gestalt of operation of the 1st of this invention as shown in drawing 1 is equipment which it is the fission reactor 15 equipped with the burner section 14 for combustion which has the carbon content compound feed hoppers 11 and 12 and the oxygen content gas supply opening 13, the carbon content compound and oxygen content gas used as a raw material are used, and a carbon content compound is burned (incomplete combustion), and manufactures fullerene. Hereafter, it explains in detail.

[0011] The burner section 14 for combustion prepared in the fission reactor 15 bottom (upstream) is equipped with the casing 16 of the shape of a cylinder in which the upper part carried out opening, and the piping 17 and 18 for supplying a carbon content compound to the center section and inside periphery of this casing 16, respectively. These piping 17 and 18 branches and forms the piping 19 to which a carbon content compound is supplied, and from this junction X, bulbs 20 and 21 are formed in the piping 17 and 18 of the downstream, respectively, and it can adjust now the amount of supply of the carbon content compound which flows each piping 17 and 18 to it. In addition, it has much piping 18 attached in the inside periphery of casing 16 at equal intervals, and the adiabatic wall 22 is attached in the perimeter moreover applied to upper limit from the center section of this piping 18. Moreover, the height of the piping 17 prepared in the center section serves as one half extent of the height of the piping 18 prepared in the inside periphery of casing 16, and the carbon content compound feed hoppers 11 and 12 are formed in the upper limit section of each piping 17 and 18, respectively. In addition, a stabilizer 23 is attached in the carbon content compound feed hopper 11 of the piping 17 prepared in the center section, and the pilot burner 24 is arranged in the side of this stabilizer 23. With this stabilizer 23, the configuration of the flame formed above the carbon content compound feed hopper 11 is stabilized.

[0012] The oxygen content gas supply opening 13 is formed, and it applies to the bottom (downstream) from the burner section 14 bottom for combustion (upstream), and has composition which can supply oxygen content gas at the bottom flank of casing 16. Thus, in the burner section 14 for combustion, multistage (it sets in the gestalt of this operation and they are two steps) is equipped with the carbon content compound feed hoppers 11 and 12 to the flow direction of the elevated-temperature gas stream formed, i.e., the flow direction of oxygen content gas. Therefore, a carbon content compound can be gradually supplied from thin low equivalent ratio to oxygen content gas.

[0013] It is attached in the upper limit of casing 16 in one, and the fission reactor 15 bottom is equipped with the approximately cylindrical reaction section 25 which the upper part reduced the diameter of gradually and carried out opening. Piping (not shown) for passing to the downstream the fullerene generated in the reaction section 25 is connected to the upper limit of this reaction section 25. On the other hand, the opening 26 which makes the bore and path of casing 16 the same is formed in the pars basilaris ossis occipitalis of the reaction section 25, and the combustion style generated from the burner section 14 for combustion flows to the reaction section 25 through this opening 26. In addition, the vacuum pump (not shown) which is an example of a vacuum means is connected to the above-mentioned fission reactor 15, and the pressure in a fission reactor 15 is made under into atmospheric pressure in it.

[0014] Thus, the perfect combustion of the carbon content compound supplied from piping 17 with constituting is carried out by a part of oxygen content gas supplied from the oxygen content gas supply opening 13, and the carbon content compound further supplied from piping 18 is made to burn completely or combust incompletely by the remaining oxygen content gas. Since a carbon content compound burns completely here when the amount of supply of the carbon content compound from piping 18 is the remaining equivalent and the remaining abbreviation equivalent amount of oxygen content gas, it is desirable to prepare a feed hopper in the pars basilaris ossis occipitalis of the reaction section 25 and/or the side-attachment-wall section, and to supply a carbon content compound. Thereby, by the combustion style generated in the burner section 14 for combustion, the pyrolysis of the supplied carbon content compound is carried out, and fullerene can be generated. On the other hand, since a

carbon content compound combusts incompletely in the burner section 14 for combustion when the amount of supply of the carbon content compound from piping 18 is more superfluous than the equivalent of the remaining oxygen content gas, fullerene generates. Therefore, although it is not necessary to prepare the feed hopper for supplying a carbon content compound to the reaction section 25, you may prepare. In addition, the whole containing the maximum upstream section of the burner section 14 for combustion except the whole burner section 14 for combustion or the upper part (downstream edge) will constitute a perfect combustion band.

[0015] Then, the manufacture approach of the fullerene concerning the gestalt of operation of the 1st of this invention is explained using the manufacturing installation 10 of fullerene. First, while supplying oxygen content gas from the oxygen content gas supply opening 13, the carbon content compound used as a fuel is supplied to the carbon content compound feed hopper 11 through piping 17, and a flame is formed using a pilot burner 24. Furthermore, a carbon content compound is supplied to two steps to the flow direction of the elevated-temperature gas stream formed, i.e., the flow direction of oxygen content gas, by supplying the carbon content compound which serves as a fuel (a fuel and raw material) from piping 18 in addition to the supply from piping 17. In addition, the oxygen content gas supplied is an amount smaller than the equivalent required in order to carry out the perfect combustion of the carbon content compound supplied from piping 17 and piping 18, an EQC, or the equivalent. Therefore, as for the amount of the carbon content compound supplied from piping 17, it is desirable to carry out to about 20 - 70% of the equivalent of oxygen content gas required in order to carry out the perfect combustion of the carbon content compound supplied from piping 17 and piping 18. In addition, the carbon content compounds supplied from piping 18 are the equivalent of the remaining oxygen content gas required in order to carry out the perfect combustion of this carbon content compound, and an EQC or a more superfluous amount.

[0016] Here, aromatic series (system) hydrocarbons, etc. such mixture, etc., such as the aliphatic series saturation which can use the thing of arbitration as a carbon content compound, for example, has a straight chain or branched chain, such as methane, such as petroleum system liquid fuel, such as petroleum system liquid fuel, such as fuel gas, such as hydrogen, a carbon monoxide, natural gas, and petroleum gas, and a fuel oil, and creosote oil, ethane, a propane, ethylene, and a propylene, or unsaturated hydrocarbon, benzene, toluene, O-xylene, meta xylene, para xylene, naphthalene, and an anthracene, be mentioned The aromatic hydrocarbon refined especially is desirable and it is desirable to use aromatic hydrocarbon, such as benzene and toluene, especially. In addition, its higher one is desirable, and when using aromatic hydrocarbon especially, it is so good that the purity of the purity of a raw material is close to 100%.

[0017] Moreover, it is desirable to use pure oxygen (that whose amount of inert gas in oxygen content gas is 0%), and the gas which exceeds 0 and contains the inert gas not more than 90 mol % (for example, gaseous helium, argon gas) as oxygen content gas. Here, the fullerene which oxygen made the ambient atmosphere in a fission reactor the thin condition, and was equipped with uniform quality can be manufactured so that there are many amounts of the inert gas in oxygen content gas, but when the amount of inert gas exceeds 90-mol %, the amount of oxygen for making heat energy required for manufacture of fullerene cannot be secured. In addition, as for inert gas, it is possible to supply from the exclusive nozzle for supply, and to also make it mix beforehand in a carbon content compound and/or oxygen content gas.

[0018] In addition, in order that the pressure in the reaction section 25 (inside of a fission reactor 15) may raise the generation effectiveness of the fullerene to generate, it is desirable to be preferably referred to as 50 - 400torr, and further 100 - 400torr ten to 500 torr under atmospheric pressure. Moreover, since a carbon content compound is supplied to multistage to oxygen content gas, the generation field of fullerene, i.e., the gas stream in the reaction section 25, serves as a laminar flow (for example, 10 - 100 cm/sec extent) at least. In addition, although it may turn into a turbulent flow, if the effect on the reaction section 25 is taken into consideration, it is desirable [the gas stream of the burner section 14 for combustion] to become a laminar flow. And in order to make a carbon content compound react by making homogeneity evaporate (pyrolysis), it is desirable to make enough the generation field

of fullerene, i.e., the temperature in the reaction section 25, into an elevated-temperature ambient atmosphere, and it is desirable to make preferably 600-2300 degrees C of mean temperature in the reaction section 25 into the range of 1000-2000 degrees C and further 1200-1800 degrees C. The carbon content compound used as the basis of this condition and a raw material is burned (incomplete combustion), and a fission reactor 15 is made to generate rough fullerene.

[0019] The rough fullerene (for example, fullerene containing the high order fullerene which has C60, C70, and the molecular weight beyond this) and the other soot components which were generated with the fission reactor 15 are separated from combustion gas in the separation section. And what is necessary is just to separate fullerene and other soot components by a well-known solvent extraction method, the well-known sublimating method, etc. conventionally. In addition, in case it is made to generate with a combustion method, by carrying out a temperature control, fullerene may be made into a gaseous state and fullerene may be separated with other soot components in the separation section by making other soot components into a solid state. For that, it is required to make temperature of the rough fullerene included in the separation section into 300 degrees C or more. In addition, at less than 300 degrees C, since a part of generated fullerene will be in a solid state and cannot pass the separation section, the amount of recovery may decrease. On the other hand, if temperature is too high, degradation of the separation section may be promoted, and a part of soot components other than fullerene may pass, and it may mix the separation section into the collected fullerene. For this reason, it is desirable to make temperature of rough fullerene into 300-2300 degrees C and further 300-1500 degrees C.

[0020] Next, although the manufacturing installation 30 of the fullerene concerning the gestalt of operation of the 2nd of this invention is explained, since it is the same as that of the manufacturing installation 10 of the fullerene concerning the gestalt of operation of the 1st of this invention, the reaction section 25 of a fission reactor 31 attaches the same number, and omits detailed explanation. The manufacturing installation 30 of the fullerene which starts the gestalt of operation of the 2nd of this invention as shown in drawing 2 is equipment which it is the fission reactor 31 equipped with the burner section 35 for combustion which has the carbon content compound feed hopper 32 and the oxygen content gas supply openings 33 and 34, the carbon content compound and oxygen content gas used as a raw material are used, and a carbon content compound is burned (incomplete combustion), and manufactures fullerene.

[0021] The burner section 35 for combustion prepared in the fission reactor 31 bottom (upstream) is equipped with the casing 36 of the shape of a cylinder in which the upper part carried out opening. A through tube 37 is formed in the pars basilaris ossis occipitalis of this casing 36, and it has the tubed lobe 38 which makes a through tube 37 and an axial center the same under the casing 36 (upstream). And the piping 39 for supplying a carbon content compound to the interior of this lobe 38 along with the axial center of a lobe 38 is arranged. The upper part of this piping 39 penetrated the through tube 37, and has projected it slightly to the casing 36 side, and the carbon content compound feed hopper 32 is formed in the upper limit of this piping 39. In addition, the oxygen content gas supply opening 33 is formed in the flank of a lobe 38. Moreover, the oxygen content gas supply opening 34 is formed also in the bottom flank of casing 36, in the center section of casing 36, the tubed separation wall 40 is arranged along with the axial center of a through tube 37, and the lower limit of this separation wall 40 is attached in the bottom of casing 36. Thereby, the oxygen content gas supplied from the lobe 37 can be supplied to the carbon content compound feed hopper 32, without making the oxygen content gas supplied from casing 36 contact.

[0022] And the separation board 41 which classifies casing 36 the bottom and the bottom is attached in the upper limit of this separation wall 40. Opening 42 is formed in the center section of this separation board 41, and two or more through tubes 43 prepared at equal intervals on the same periphery are formed in it at the periphery of the separation board 41. The carbon content compound with which the oxygen content gas supplied from the oxygen content gas supply opening 34 remained with the casing 36 up side by this, and a reaction are possible. Thus, in the burner section 35 for combustion, multistage (it sets in the gestalt of this operation and they are two steps) is equipped with the oxygen content gas supply openings 33 and 34 to the flow direction of the elevated-temperature gas stream formed, i.e., the

flow direction of a carbon content compound. Therefore, oxygen content gas can be gradually supplied from thin low equivalent ratio to a carbon content compound.

[0023] Thus, the equivalent required in order to carry out the perfect combustion of some carbon content compounds supplied from the carbon content compound feed hopper 32 by the oxygen content gas supplied from the lobe 38 and to carry out the perfect combustion of the further remaining carbon content compounds with constituting, an EQC, or oxygen content gas fewer than it is supplied from the casing 36 bottom, and a carbon content compound is made to burn completely or combust incompletely. Since a carbon content compound burns completely when the amount of supply of the oxygen content gas supplied from the casing 36 bottom is the remaining equivalent and the remaining abbreviation equivalent amount of a carbon content compound here, it is desirable to prepare a feed hopper in the pars basilaris ossis occipitalis of the reaction section 25 and/or the side-attachment-wall section, and to supply a carbon content compound. Thereby, by the combustion style generated in the burner section 35 for combustion, the pyrolysis of the supplied carbon content compound is carried out, and fullerene can be generated. On the other hand, since a carbon content compound combusts incompletely in the burner section 35 for combustion when there is less amount of supply of the oxygen content gas supplied from the casing 36 bottom than the equivalent of the remaining carbon content compounds, fullerene generates. Therefore, although it is not necessary to prepare the feed hopper for supplying a carbon content compound to the reaction section 25, you may prepare. In addition, the whole containing the maximum upstream section of the burner section 35 for combustion except the whole burner section 35 for combustion or the upper part (downstream edge) will constitute a perfect combustion band.

[0024] Then, except the combustion method of the combustion burner section 35, although the manufacture approach of the fullerene concerning the gestalt of operation of the 2nd of this invention is explained using the manufacturing installation 30 of fullerene, since it is the same as the manufacture approach of the fullerene concerning the gestalt of operation of the 1st of this invention, only the combustion method of the combustion burner section 35 is explained. First, while supplying the carbon content compound used as a fuel (a fuel and raw material) to the carbon content compound feed hopper 32 through piping 39, oxygen content gas is supplied from the oxygen content gas supply opening 33 of a lobe 38, and a flame is formed. At this time, there is less amount of supply of oxygen content gas than a complement in order to carry out the perfect combustion of the carbon content compound supplied (for example, about 20 - 70% of the equivalent required in order to carry out the perfect combustion of the carbon content compound). Furthermore, carbon content gas is supplied to two steps from the oxygen content gas supply opening 34 of the casing 36 bottom by supplying oxygen content gas to the flow direction of the elevated-temperature gas stream formed, i.e., the flow direction of a carbon content compound. This amount of supply is an amount smaller than the equivalent required in order to carry out the perfect combustion of the remaining carbon content compounds, an EQC, or the equivalent. And the pressure in the reaction section 25 (inside of a fission reactor 31), a gas stream, and temperature are set as the above mentioned conditions, the incomplete combustion of the carbon content compound used as a raw material is carried out, and fullerene is made to generate.

[0025] the manufacture approach of the fullerene which the manufacture approach of fullerene using the manufacturing installation 50 of this fullerene requires for the gestalt of operation of the 1st of this invention although the manufacturing installation 50 of the fullerene concerning the gestalt of operation of the 3rd of this invention is explained, and abbreviation -- since it is the same, explanation is omitted. The manufacturing installation 50 of the fullerene which starts the gestalt of operation of the 3rd of this invention as shown in drawing 3 is equipment which it is the fission reactor 55 equipped with the burner section 54 for combustion which has the carbon content compound feed hoppers 51 and 52 and the oxygen content gas supply opening 53, the carbon content compound and oxygen content gas used as a raw material are used, and a carbon content compound is burned (incomplete combustion), and manufactures fullerene. Hereafter, it explains in detail.

[0026] The fission reactor 55 bottom is equipped with the approximately cylindrical reaction section 56 which the upper part reduced the diameter of gradually and carried out opening. Piping (not shown) for passing to the downstream the fullerene generated in the reaction section 56 is connected to the upper

limit of this reaction section 56. On the other hand, the lower limit of the reaction section 56 is equipped with a path slightly smaller than the reaction section 56, and the piping 57 for supplying oxygen content gas is attached in it in one. Moreover, after incorporating the piping 59 which branched from the piping 58 which supplies a carbon content compound to the interior of this piping 57 and branching this piping 59 further, the upper limit (downstream) of the branched piping 60 is attached in the lower limit of the reaction section 56 in one. In addition, the bulb 61 which enables adjustment of the amount of supply of the carbon content compound from each piping 60 respectively is attached in the downstream from the branch point of two or more piping 60 after branching.

[0027] And the carbon content compound feed hopper 51 for supplying a carbon content compound is formed in the height, for example, 1 / about four to 1/2 location, of the bottom flank 56 of the reaction section 56, i.e., the reaction section. As for this carbon content compound feed hopper 51, it is desirable that more than one are equiangularly prepared in the perimeter of the reaction section 56 to the axial center of the reaction section 56. Here, supply of a carbon content compound is enabled into the reaction section 56 by the piping 62 which branched from piping 58 being attached in the carbon content compound feed hopper 51. A bulb 63 is attached also in this piping 62, and adjustment of the amount of supply of a carbon content compound is enabled. In addition, two or more through tubes are prepared in the pars basilaris ossis occipitalis of the reaction section 56, and this through tube constitutes the carbon content compound feed hopper 52 and the oxygen content gas supply opening 53 at it. Here, it may be arbitrary, and plane view of the configuration of two or more of these through tubes may be carried out, and they may be circular, an ellipse form, a rectangle, a polygon, etc. and the indeterminate form of a gourd mold substantially. Moreover, although the arrangement location of a through tube is arbitrary, in order to pass a combustion style to homogeneity to the reaction section 56, the thing which were centered on the axial center of the reaction section 56 and for which it is regular intervals and two or more through tubes are arranged on the same or a concentric circle periphery is desirable. Under the present circumstances, even if the open end of a through tube is on the base of the reaction section 56, and an abbreviation same flat surface, you may project and the number of a through tube is arbitrary. Here, the burner section 54 for combustion also has above-mentioned piping 57-60 and above-mentioned piping 62.

[0028] Thus, in the burner section 54 for combustion, multistage (it sets in the gestalt of this operation and they are two steps) is equipped with the carbon content compound feed hoppers 51 and 52 to the flow direction of the elevated-temperature gas stream formed, i.e., the flow direction of oxygen content gas. Therefore, a carbon content compound can be gradually supplied from thin low equivalent ratio to oxygen content gas. In addition, although the case where a carbon content compound was supplied to multistage was explained by preparing a carbon content compound feed hopper in multistage, oxygen content gas may be supplied to a single stage here by exchanging the feed hopper of a carbon content compound and oxygen content gas, and preparing oxygen content gas supply opening in multistage. The vacuum pump (not shown) which is an example of a vacuum means is connected to the above-mentioned reaction section 56, and the pressure in the reaction section 56 is made under into atmospheric pressure at it.

[0029] As mentioned above, although this invention has been explained with reference to the gestalt of operation, this invention is not limited to a configuration given in the gestalt of operation described above in any way, and also includes the gestalt and modification of other operations which are considered within the limits of the matter indicated by the claim. For example, in the gestalt of said operation, the case where it had a carbon content compound feed hopper or two steps of oxygen content gas supply openings to the flow direction of the gas of the elevated-temperature gas stream formed, respectively was explained. However, it is also possible to have a carbon content compound feed hopper or three or more steps of oxygen content gas supply openings, and it is also still more possible to have a carbon content compound feed hopper and two or more steps of oxygen content gas supply openings, respectively. Moreover, it is also possible to arrange a carbon content compound feed hopper and/or oxygen content gas supply opening in the location of arbitration, and to prepare for multistage.

[0030] Moreover, in the gestalt of said 1st [the] and the 2nd operation, the case where the one burner

section for combustion prepared in the fission reactor bottom was attached was explained. However, it is also possible to prepare two or more burner sections for combustion in the fission reactor bottom. In this case, at the pars basilaris ossis occipitalis of the reaction section, it is desirable to form opening in the location corresponding to the anchoring part of the burner section for combustion, respectively. Thereby, a rapid cubical expansion at the time of combustion with a carbon content compound and oxygen content gas can be controlled further. And in the gestalt of said operation, although a carbon content compound explains combustion, for example, when incomplete combustion was carried out and fullerene is made to generate, even when perfect combustion is carried out, fullerene may generate.
[0031]
[Effect of the Invention] In the manufacturing installation of fullerene according to claim 1 to 4, and the manufacture approach of fullerene according to claim 5 to 11, since a carbon content compound and/or oxygen content gas can be divided and supplied, a rapid cubical expansion at the time of combustion with a carbon content compound and oxygen content gas can be controlled. Therefore, since the residence time of the fullerene precursor in the generation field of fullerene and fullerene can be lengthened as compared with the case where supplied a carbon content compound and oxygen content gas at once, and they are burned, fullerene can be manufactured cheaply and easily in large quantities.
[0032] In the manufacture approach of the fullerene according to claim 8 to 11 subordinate to the manufacturing installation of the fullerene according to claim 4 subordinate to claim 2 and this, claim 6, and this, it is the burner section for combustion and a carbon content compound can be gradually supplied from thin low equivalent ratio to oxygen content gas. Therefore, since NOx reduction in nitrogen-oxides reduction reaction time with a high concentration carbon content compound can be aimed at in addition to the reduction effectiveness of the NOx discharge by the low equivalent ratio of a carbon content compound, when atmospheric air mixes, for example in a fission reactor, the possibility of air pollution can be reduced.
[0033] In the manufacture approach of the fullerene according to claim 8 to 11 subordinate to the manufacturing installation of the fullerene according to claim 4 subordinate to claim 3 and this, claim 7, and this, it is the burner section for combustion and oxygen content gas can be gradually supplied from thin low equivalent ratio to a carbon content compound. Therefore, since it can control that an elevated-temperature field is formed in the interior of a flame as much as possible and reduction of NOx can be aimed at, when atmospheric air mixes, for example in a fission reactor, the possibility of air pollution can be reduced. Especially, in the manufacturing installation of fullerene according to claim 4, the perfect combustion of a carbon content compound and the oxygen content gas can be carried out in the maximum upstream section of the burner section for combustion. Therefore, since the reaction effectiveness of the carbon content compound and oxygen content gas in the maximum upstream section of the burner section for combustion is raised, fullerene is economically generable.
[0034] In the manufacture approach of fullerene according to claim 8, since fullerene is generated under the pressure of 10 - 500torr, the generation effectiveness of fullerene can be raised. In the manufacture approach of fullerene according to claim 9, since the gas stream of the generation field of fullerene is made into a laminar flow, the residence time of the fullerene precursor in the generation field of fullerene and fullerene can be lengthened further, and the generation effectiveness of fullerene can be raised. In the manufacture approach of fullerene according to claim 10, since fullerene is generated under a thin oxygen condition, the temperature distribution of the generation field of fullerene are made into homogeneity, and the fullerene of the stable quality can be manufactured. In the manufacture approach of fullerene according to claim 11, it is making temperature of the generation field of fullerene into a 600-2300-degree C elevated temperature, and make homogeneity evaporate a carbon content compound, it is made to react, and the fullerene of the stable quality can be manufactured.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the manufacturing installation and its manufacture approach of the fullerene which can manufacture fullerene (for example, C60, C70 grade).

[Translation done.]

PRIOR ART

[Description of the Prior Art] Fullerene (henceforth fullerene) is the generic name of the third carbon allotrope which ranks second to a diamond and a graphite, and as represented in C60, C70, etc., it is the carbon molecule of the shape of hollow husks closed in the network of five membered-rings and six membered-rings. Although it is comparatively that existence of this fullerene was finally checked and it is a comparatively new carbon material, it is admitted that that special molecular structure, therefore specific physical property are shown, for example, innovative application development is being quickly developed over the wide range following fields.
(1) Since manufacture of an artificial diamond with a fine crystal grain child is attained by using application fullerene to a superhard ingredient as a precursor, use to an abrasion resistance material with added value is expected.
(2) By using application C60 derivative and the optical device to drugs, research as an application of an anticancer agent, an acquired immunode-ficiency syndrome, osteoporosis, the Alzheimer remedy, a contrast medium, a stent ingredient, etc. is advanced.
(3) It is discovered that the superconducting material which has a high transition temperature called 18K with doping metallic potassium in the application fullerene thin film to a superconducting material can be manufactured, and since various, attract attention.
(4) By mixing C60 with the application resist to semi-conductor manufacture, it uses that resist structure is strengthened further and the application to manufacture of a next-generation semi-conductor is expected. Thus, since fullerene is various as the exotic material which bears the next generation, and new materials, it attracts attention. In addition, C60 and C70 are comparatively easy to compound also in the fullerene which has various carbon numbers, and it is expected that future need so also increases explosively.
[0003] Moreover, the approach shown below is mentioned as the manufacture approach of fullerene learned now.
(1) Laser vacuum deposition : how to irradiate the pulse laser of a high energy consistency at the carbon target placed into rare gas, and compound by evaporation of a carbon atom. First, the quartz tube with which rare gas flows is placed into an electric furnace, and a graphite sample is placed into the quartz tube. And the soot (soot) containing fullerene, such as C60 and C70, is made to adhere to the wall of the quartz tube with which near the electric furnace outlet got cold by irradiating laser and evaporating it in a graphite sample, from the upstream of the flow of gas. In addition, since this laser vacuum deposition has the slight evaporation per laser shot of a graphite sample, it is unsuitable for extensive manufacture.
(2) Resistance heating method : the approach to which carry out energization heating and a graphite rod is made to sublimate in the container of the vacuum filled with gaseous helium. In addition, since this resistance heating method has the large electric resistance loss in a circuit, it is unsuitable for extensive manufacture.
(3) Arc discharge method : the approach to which the carbon of a lifting and an anode plate is made to sublimate arc discharge in the condition of having contacted two graphite electrodes lightly in the gaseous helium in dozens kPa(s), or having detached about 1-2mm. This arc discharge method is used

for extensive manufacture on a current works scale.
(4) Radio frequency heating method : how to heat a sink and a graphite raw material in a graphite raw material by RF induction, and to evaporate an eddy current instead of using resistance heating and arc discharge.
(5) Combustion method : the approach of carrying out the incomplete combustion of the hydrocarbon raw materials, such as benzene, in the mixed gas of inert gas, such as helium, and oxygen. Since several% of a benzene fuel serves as soot and those about 10% becomes fullerene when this combustion method is used, manufacture effectiveness is not good. However, the soot (fullerene etc.) to reproduce is observed as the mass-producing method for opposing an arc discharge method at the point usable to liquid fuel etc., and the point that a manufacturing installation is simple.
(6) Naphthalene thermal decomposition method : the approach of carrying out the pyrolysis of the naphthalene at about 1000 degrees C.
[0004] Although the synthesis method of various fullerene to current was proposed as described above, the method of manufacturing fullerene cheaply and in large quantities by any approach until now was not established. However, toward mass production method of fullerene, the maximum temperature in the synthetic region of fullerene is low temperature comparatively compared with about 1700 degrees C and other approaches, and can manufacture [be / it / under / of the above-mentioned approach / setting] a combustion method easily compared with other approaches. For example, the manufacture approach of the fullerene which a carbon content compound (hydrocarbon raw material) is burned in a flame in the Patent Publication Heisei No. 507879 [six to] official report, and collects condensates in it is proposed.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
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EFFECT OF THE INVENTION

[Effect of the Invention] In the manufacturing installation of fullerene according to claim 1 to 4, and the manufacture approach of fullerene according to claim 5 to 11, since a carbon content compound and/or oxygen content gas can be divided and supplied, a rapid cubical expansion at the time of combustion with a carbon content compound and oxygen content gas can be controlled. Therefore, since the residence time of the fullerene precursor in the generation field of fullerene and fullerene can be lengthened as compared with the case where supplied a carbon content compound and oxygen content gas at once, and they are burned, fullerene can be manufactured cheaply and easily in large quantities.
[0032] In the manufacture approach of the fullerene according to claim 8 to 11 subordinate to the manufacturing installation of the fullerene according to claim 4 subordinate to claim 2 and this, claim 6, and this, it is the burner section for combustion and a carbon content compound can be gradually supplied from thin low equivalent ratio to oxygen content gas. Therefore, since NOx reduction in nitrogen-oxides reduction reaction time with a high concentration carbon content compound can be aimed at in addition to the reduction effectiveness of the NOx discharge by the low equivalent ratio of a carbon content compound, when atmospheric air mixes, for example in a fission reactor, the possibility of air pollution can be reduced.
[0033] In the manufacture approach of the fullerene according to claim 8 to 11 subordinate to the manufacturing installation of the fullerene according to claim 4 subordinate to claim 3 and this, claim 7, and this, it is the burner section for combustion and oxygen content gas can be gradually supplied from thin low equivalent ratio to a carbon content compound. Therefore, since it can control that an elevated-temperature field is formed in the interior of a flame as much as possible and reduction of NOx can be aimed at, when atmospheric air mixes, for example in a fission reactor, the possibility of air pollution can be reduced. Especially, in the manufacturing installation of fullerene according to claim 4, the perfect combustion of a carbon content compound and the oxygen content gas can be carried out in the maximum upstream section of the burner section for combustion. Therefore, since the reaction effectiveness of the carbon content compound and oxygen content gas in the maximum upstream section of the burner section for combustion is raised, fullerene is economically generable.
[0034] In the manufacture approach of fullerene according to claim 8, since fullerene is generated under the pressure of 10 - 500torr, the generation effectiveness of fullerene can be raised. In the manufacture approach of fullerene according to claim 9, since the gas stream of the generation field of fullerene is made into a laminar flow, the residence time of the fullerene precursor in the generation field of fullerene and fullerene can be lengthened further, and the generation effectiveness of fullerene can be raised. In the manufacture approach of fullerene according to claim 10, since fullerene is generated under a thin oxygen condition, the temperature distribution of the generation field of fullerene are made into homogeneity, and the fullerene of the stable quality can be manufactured. In the manufacture approach of fullerene according to claim 11, it is making temperature of the generation field of fullerene into a 600-2300-degree C elevated temperature, and make homogeneity evaporate a carbon content compound, it is made to react, and the fullerene of the stable quality can be manufactured.

[Translation done.]

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, there are the following problems in the manufacture approach of the fullerene by the above-mentioned combustion method. Although it is contained in the soot-like matter and generated, since the rate of fullerene of the fullerene contained in the soot-like matter in a combustion method is low, it is not economical. Then, it has been a big technical problem how the generation rate of this fullerene is raised. Moreover, if a flame is made to form into the closed container generally, the rate-of-flow difference will arise in parts other than a flame core and a flame, and the rate of flow of the flame core where a combustion reaction is performed actively will become quick. For this reason, a back flow and contamination of the combustion gas from the upstream happen in the flame periphery section, and self-circulation occurs in many cases. Such self-circulation of exhaust gas prevents local elevated-temperature-ization of flame temperature, and while there is effectiveness which controls generating of NOx, it brings about ununiformity-ization of the residence time in the generation process (generation field) of fullerene. That is, as for the fullerene precursor with which, as for the fullerene precursor which rode the flow of this circulating gas in the phase which fullerene is generating in the flame, the residence time does not ride the flow of circulating gas on the other hand by becoming long, the residence time will become short if self-circulation occurs. Therefore, yield of fullerene is worsened and a presentation serves as an ununiformity. This invention was made in view of this situation, and controls the residence time of the fullerene precursor in the generation field of fullerene, and fullerene, and it aims at offering the manufacturing installation and its manufacture approach of the fullerene which can be manufactured cheaply and easily in large quantities [fullerene].

[Translation done.]

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MEANS

[Means for Solving the Problem] The manufacturing installation of the fullerene concerning the 1st invention in alignment with said purpose is a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, is a manufacturing installation which the carbon content compound and oxygen content gas used as a raw material are burned, and manufactures fullerene, and equips multistage with a carbon content compound feed hopper and oxygen content gas supply opening. Thus, since a carbon content compound and oxygen content gas are divided, respectively and can be supplied with constituting, a rapid cubical expansion at the time of combustion with a carbon content compound and oxygen content gas can be controlled. The manufacturing installation of the fullerene concerning the 2nd invention in alignment with said purpose is a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, is a manufacturing installation which the carbon content compound and oxygen content gas used as a raw material are burned, and manufactures fullerene, and equips multistage with a carbon content compound feed hopper. Thus, with constituting, a carbon content compound can be gradually supplied from thin low equivalent ratio to oxygen content gas in the burner section for combustion. The manufacturing installation of the fullerene concerning the 3rd invention in alignment with said purpose is a fission reactor equipped with the burner section for combustion which has a carbon content compound feed hopper and oxygen content gas supply opening, is a manufacturing installation which the carbon content compound and oxygen content gas used as a raw material are burned, and manufactures fullerene, and equips multistage with oxygen content gas supply opening. Thus, with constituting, oxygen content gas can be gradually supplied from thin low equivalent ratio to a carbon content compound in the burner section for combustion. Here, in the manufacturing installation of the fullerene concerning the 1st - the 3rd invention, it is desirable to form a perfect combustion band in the maximum upstream section of the burner section for combustion. Thereby, in the maximum upstream section of the burner section for combustion, the perfect combustion of a carbon content compound and the oxygen content gas can be carried out.
[0007] The manufacture approach of the fullerene concerning the 1st invention in alignment with said purpose burns the carbon content compound and oxygen content gas used as a raw material under in atmospheric pressure, and supplies a carbon content compound and oxygen content gas to multistage in the approach of manufacturing fullerene, respectively. Since combustion with a carbon content compound and oxygen content gas can be divided and can be performed by this, a rapid cubical expansion at the time of combustion with a carbon content compound and oxygen content gas can be controlled. The manufacture approach of the fullerene concerning the 2nd invention in alignment with said purpose burns the carbon content compound and oxygen content gas used as a raw material under in atmospheric pressure, and supplies a carbon content compound to multistage in the approach of manufacturing fullerene. Thereby, in the burner section for combustion, to oxygen content gas, a carbon content compound can be supplied gradually and can be burned from thin low equivalent ratio. The manufacture approach of the fullerene concerning the 3rd invention in alignment with said purpose

burns the carbon content compound and oxygen content gas used as a raw material under in atmospheric pressure, and supplies oxygen content gas to multistage in the approach of manufacturing fullerene. Thereby, in the burner section for combustion, to a carbon content compound, oxygen content gas can be supplied gradually and can be burned from thin low equivalent ratio.

[0008] Here, in the manufacture approach of the fullerene concerning the 1st - the 3rd invention, it is desirable to generate fullerene by 10 - 500torr. In the manufacture approach of the fullerene concerning the 1st - the 3rd invention, it is desirable to make the gas stream of the generation field of fullerene into a laminar flow at least. In the manufacture approach of the fullerene concerning the 1st - the 3rd invention, it is desirable that exceed 0 or 0 and the inert gas not more than 90 mol % is contained in oxygen content gas. In the manufacture approach of the fullerene concerning the 1st - the 3rd invention, it is desirable to make temperature of the generation field of fullerene into the range of 600-2300 degrees C.

[0009]

[Embodiment of the Invention] Then, referring to the attached drawing, it explains per gestalt of the operation which materialized this invention, and an understanding of this invention is presented. The explanatory view of the manufacturing installation of the fullerene which drawing 1 requires for the gestalt of operation of the 1st of this invention here, the explanatory view of the manufacturing installation of the fullerene which drawing 2 requires for the gestalt of operation of the 2nd of this invention, and drawing 3 are the explanatory views of the manufacturing installation of the fullerene concerning the gestalt of operation of the 3rd of this invention.

[0010] The manufacturing installation 10 of the fullerene which starts the gestalt of operation of the 1st of this invention as shown in drawing 1 is equipment which it is the fission reactor 15 equipped with the burner section 14 for combustion which has the carbon content compound feed hoppers 11 and 12 and the oxygen content gas supply opening 13, the carbon content compound and oxygen content gas used as a raw material are used, and a carbon content compound is burned (incomplete combustion), and manufactures fullerene. Hereafter, it explains in detail.

[0011] The burner section 14 for combustion prepared in the fission reactor 15 bottom (upstream) is equipped with the casing 16 of the shape of a cylinder in which the upper part carried out opening, and the piping 17 and 18 for supplying a carbon content compound to the center section and inside periphery of this casing 16, respectively. These piping 17 and 18 branches and forms the piping 19 to which a carbon content compound is supplied, and from this junction X, bulbs 20 and 21 are formed in the piping 17 and 18 of the downstream, respectively, and it can adjust now the amount of supply of the carbon content compound which flows each piping 17 and 18 to it. In addition, it has much piping 18 attached in the inside periphery of casing 16 at equal intervals, and the adiabatic wall 22 is attached in the perimeter moreover applied to upper limit from the center section of this piping 18. Moreover, the height of the piping 17 prepared in the center section serves as one half extent of the height of the piping 18 prepared in the inside periphery of casing 16, and the carbon content compound feed hoppers 11 and 12 are formed in the upper limit section of each piping 17 and 18, respectively. In addition, a stabilizer 23 is attached in the carbon content compound feed hopper 11 of the piping 17 prepared in the center section, and the pilot burner 24 is arranged in the side of this stabilizer 23. With this stabilizer 23, the configuration of the flame formed above the carbon content compound feed hopper 11 is stabilized.

[0012] The oxygen content gas supply opening 13 is formed, and it applies to the bottom (downstream) from the burner section 14 bottom for combustion (upstream), and has composition which can supply oxygen content gas at the bottom flank of casing 16. Thus, in the burner section 14 for combustion, multistage (it sets in the gestalt of this operation and they are two steps) is equipped with the carbon content compound feed hoppers 11 and 12 to the flow direction of the elevated-temperature gas stream formed, i.e., the flow direction of oxygen content gas. Therefore, a carbon content compound can be gradually supplied from thin low equivalent ratio to oxygen content gas.

[0013] It is attached in the upper limit of casing 16 in one, and the fission reactor 15 bottom is equipped with the approximately cylindrical reaction section 25 which the upper part reduced the diameter of gradually and carried out opening. Piping (not shown) for passing to the downstream the fullerene

generated in the reaction section 25 is connected to the upper limit of this reaction section 25. On the other hand, the opening 26 which makes the bore and path of casing 16 the same is formed in the pars basilaris ossis occipitalis of the reaction section 25, and the combustion style generated from the burner section 14 for combustion flows to the reaction section 25 through this opening 26. In addition, the vacuum pump (not shown) which is an example of a vacuum means is connected to the above-mentioned fission reactor 15, and the pressure in a fission reactor 15 is made under into atmospheric pressure in it.

[0014] Thus, the perfect combustion of the carbon content compound supplied from piping 17 with constituting is carried out by a part of oxygen content gas supplied from the oxygen content gas supply opening 13, and the carbon content compound further supplied from piping 18 is made to burn completely or combust incompletely by the remaining oxygen content gas. Since a carbon content compound burns completely here when the amount of supply of the carbon content compound from piping 18 is the remaining equivalent and the remaining abbreviation equivalent amount of oxygen content gas, it is desirable to prepare a feed hopper in the pars basilaris ossis occipitalis of the reaction section 25 and/or the side-attachment-wall section, and to supply a carbon content compound. Thereby, by the combustion style generated in the burner section 14 for combustion, the pyrolysis of the supplied carbon content compound is carried out, and fullerene can be generated. On the other hand, since a carbon content compound combusts incompletely in the burner section 14 for combustion when the amount of supply of the carbon content compound from piping 18 is more superfluous than the equivalent of the remaining oxygen content gas, fullerene generates. Therefore, although it is not necessary to prepare the feed hopper for supplying a carbon content compound to the reaction section 25, you may prepare. In addition, the whole containing the maximum upstream section of the burner section 14 for combustion except the whole burner section 14 for combustion or the upper part (downstream edge) will constitute a perfect combustion band.

[0015] Then, the manufacture approach of the fullerene concerning the gestalt of operation of the 1st of this invention is explained using the manufacturing installation 10 of fullerene. First, while supplying oxygen content gas from the oxygen content gas supply opening 13, the carbon content compound used as a fuel is supplied to the carbon content compound feed hopper 11 through piping 17, and a flame is formed using a pilot burner 24. Furthermore, a carbon content compound is supplied to two steps to the flow direction of the elevated-temperature gas stream formed, i.e., the flow direction of oxygen content gas, by supplying the carbon content compound which serves as a fuel (a fuel and raw material) from piping 18 in addition to the supply from piping 17. In addition, the oxygen content gas supplied is an amount smaller than the equivalent required in order to carry out the perfect combustion of the carbon content compound supplied from piping 17 and piping 18, an EQC, or the equivalent. Therefore, as for the amount of the carbon content compound supplied from piping 17, it is desirable to carry out to about 20 - 70% of the equivalent of oxygen content gas required in order to carry out the perfect combustion of the carbon content compound supplied from piping 17 and piping 18. In addition, the carbon content compounds supplied from piping 18 are the equivalent of the remaining oxygen content gas required in order to carry out the perfect combustion of this carbon content compound, and an EQC or a more superfluous amount.

[0016] Here, aromatic series (system) hydrocarbons, etc. such mixture, etc., such as the aliphatic series saturation which can use the thing of arbitration as a carbon content compound; for example, has a straight chain or branched chain, such as methane, such as petroleum system liquid fuel, such as petroleum system liquid fuel, such as fuel gas, such as hydrogen, a carbon monoxide, natural gas, and petroleum gas, and a fuel oil, and creosote oil, ethane, a propane, ethylene, and a propylene, or unsaturated hydrocarbon, benzene, toluene, O-xylene, meta xylene, para xylene, naphthalene, and an anthracene, be mentioned The aromatic hydrocarbon refined especially is desirable and it is desirable to use aromatic hydrocarbon, such as benzene and toluene, especially. In addition, its higher one is desirable, and when using aromatic hydrocarbon especially, it is so good that the purity of the purity of a raw material is close to 100%.

[0017] Moreover, it is desirable to use pure oxygen (that whose amount of inert gas in oxygen content

gas is 0%), and the gas which exceeds 0 and contains the inert gas not more than 90 mol % (for example, gaseous helium, argon gas) as oxygen content gas. Here, the fullerene which oxygen made the ambient atmosphere in a fission reactor the thin condition, and was equipped with uniform quality can be manufactured so that there are many amounts of the inert gas in oxygen content gas, but when the amount of inert gas exceeds 90-mol %, the amount of oxygen for making heat energy required for manufacture of fullerene cannot be secured. In addition, as for inert gas, it is possible to supply from the exclusive nozzle for supply, and to also make it mix beforehand in a carbon content compound and/or oxygen content gas.

[0018] In addition, in order that the pressure in the reaction section 25 (inside of a fission reactor 15) may raise the generation effectiveness of the fullerene to generate, it is desirable to be preferably referred to as 50 - 400torr, and further 100 - 400torr ten to 500 torr under atmospheric pressure. Moreover, since a carbon content compound is supplied to multistage to oxygen content gas, the generation field of fullerene, i.e., the gas stream in the reaction section 25, serves as a laminar flow (for example, 10 - 100 cm/sec extent) at least. In addition, although it may turn into a turbulent flow, if the effect on the reaction section 25 is taken into consideration, it is desirable [the gas stream of the burner section 14 for combustion] to become a laminar flow. And in order to make a carbon content compound react by making homogeneity evaporate (pyrolysis), it is desirable to make enough the generation field of fullerene, i.e., the temperature in the reaction section 25, into an elevated-temperature ambient atmosphere, and it is desirable to make preferably 600-2300 degrees C of mean temperature in the reaction section 25 into the range of 1000-2000 degrees C and further 1200-1800 degrees C. The carbon content compound used as the basis of this condition and a raw material is burned (incomplete combustion), and a fission reactor 15 is made to generate rough fullerene.

[0019] The rough fullerene (for example, fullerene containing the high order fullerene which has C60, C70, and the molecular weight beyond this) and the other soot components which were generated with the fission reactor 15 are separated from combustion gas in the separation section. And what is necessary is just to separate fullerene and other soot components by a well-known solvent extraction method, the well-known sublimating method, etc. conventionally. In addition, in case it is made to generate with a combustion method, by carrying out a temperature control, fullerene may be made into a gaseous state and fullerene may be separated with other soot components in the separation section by making other soot components into a solid state. For that, it is required to make temperature of the rough fullerene included in the separation section into 300 degrees C or more. In addition, at less than 300 degrees C, since a part of generated fullerene will be in a solid state and cannot pass the separation section, the amount of recovery may decrease. On the other hand, if temperature is too high, degradation of the separation section may be promoted, and a part of soot components other than fullerene may pass, and it may mix the separation section into the collected fullerene. For this reason, it is desirable to make temperature of rough fullerene into 300-2300 degrees C and further 300-1500 degrees C.

[0020] Next, although the manufacturing installation 30 of the fullerene concerning the gestalt of operation of the 2nd of this invention is explained, since it is the same as that of the manufacturing installation 10 of the fullerene concerning the gestalt of operation of the 1st of this invention, the reaction section 25 of a fission reactor 31 attaches the same number, and omits detailed explanation. The manufacturing installation 30 of the fullerene which starts the gestalt of operation of the 2nd of this invention as shown in <u>drawing 2</u> is equipment which it is the fission reactor 31 equipped with the burner section 35 for combustion which has the carbon content compound feed hopper 32 and the oxygen content gas supply openings 33 and 34, the carbon content compound and oxygen content gas used as a raw material are used, and a carbon content compound is burned (incomplete combustion), and manufactures fullerene.

[0021] The burner section 35 for combustion prepared in the fission reactor 31 bottom (upstream) is equipped with the casing 36 of the shape of a cylinder in which the upper part carried out opening. A through tube 37 is formed in the pars basilaris ossis occipitalis of this casing 36, and it has the tubed lobe 38 which makes a through tube 37 and an axial center the same under the casing 36 (upstream). And the piping 39 for supplying a carbon content compound to the interior of this lobe 38 along with the

axial center of a lobe 38 is arranged. The upper part of this piping 39 penetrated the through tube 37, and has projected it slightly to the casing 36 side, and the carbon content compound feed hopper 32 is formed in the upper limit of this piping 39. In addition, the oxygen content gas supply opening 33 is formed in the flank of a lobe 38. Moreover, the oxygen content gas supply opening 34 is formed also in the bottom flank of casing 36, in the center section of casing 36, the tubed separation wall 40 is arranged along with the axial center of a through tube 37, and the lower limit of this separation wall 40 is attached in the bottom of casing 36. Thereby, the oxygen content gas supplied from the lobe 37 can be supplied to the carbon content compound feed hopper 32, without making the oxygen content gas supplied from casing 36 contact.

[0022] And the separation board 41 which classifies casing 36 the bottom and the bottom is attached in the upper limit of this separation wall 40. Opening 42 is formed in the center section of this separation board 41, and two or more through tubes 43 prepared at equal intervals on the same periphery are formed in it at the periphery of the separation board 41. The carbon content compound with which the oxygen content gas supplied from the oxygen content gas supply opening 34 remained with the casing 36 up side by this, and a reaction are possible. Thus, in the burner section 35 for combustion, multistage (it sets in the gestalt of this operation and they are two steps) is equipped with the oxygen content gas supply openings 33 and 34 to the flow direction of the elevated-temperature gas stream formed, i.e., the flow direction of a carbon content compound. Therefore, oxygen content gas can be gradually supplied from thin low equivalent ratio to a carbon content compound.

[0023] Thus, the equivalent required in order to carry out the perfect combustion of some carbon content compounds supplied from the carbon content compound feed hopper 32 by the oxygen content gas supplied from the lobe 38 and to carry out the perfect combustion of the further remaining carbon content compounds with constituting, an EQC, or oxygen content gas fewer than it is supplied from the casing 36 bottom, and a carbon content compound is made to burn completely or combust incompletely. Since a carbon content compound burns completely when the amount of supply of the oxygen content gas supplied from the casing 36 bottom is the remaining equivalent and the remaining abbreviation equivalent amount of a carbon content compound here, it is desirable to prepare a feed hopper in the pars basilaris ossis occipitalis of the reaction section 25 and/or the side-attachment-wall section, and to supply a carbon content compound. Thereby, by the combustion style generated in the burner section 35 for combustion, the pyrolysis of the supplied carbon content compound is carried out, and fullerene can be generated. On the other hand, since a carbon content compound combusts incompletely in the burner section 35 for combustion when there is less amount of supply of the oxygen content gas supplied from the casing 36 bottom than the equivalent of the remaining carbon content compounds, fullerene generates. Therefore, although it is not necessary to prepare the feed hopper for supplying a carbon content compound to the reaction section 25, you may prepare. In addition, the whole containing the maximum upstream section of the burner section 35 for combustion except the whole burner section 35 for combustion or the upper part (downstream edge) will constitute a perfect combustion band.

[0024] Then, except the combustion method of the combustion burner section 35, although the manufacture approach of the fullerene concerning the gestalt of operation of the 2nd of this invention is explained using the manufacturing installation 30 of fullerene, since it is the same as the manufacture approach of the fullerene concerning the gestalt of operation of the 1st of this invention, only the combustion method of the combustion burner section 35 is explained. First, while supplying the carbon content compound used as a fuel (a fuel and raw material) to the carbon content compound feed hopper 32 through piping 39, oxygen content gas is supplied from the oxygen content gas supply opening 33 of a lobe 38, and a flame is formed. At this time, there is less amount of supply of oxygen content gas than a complement in order to carry out the perfect combustion of the carbon content compound supplied (for example, about 20 - 70% of the equivalent required in order to carry out the perfect combustion of the carbon content compound). Furthermore, carbon content gas is supplied to two steps from the oxygen content gas supply opening 34 of the casing 36 bottom by supplying oxygen content gas to the flow direction of the elevated-temperature gas stream formed, i.e., the flow direction of a carbon content compound. This amount of supply is an amount smaller than the equivalent required in order to carry

out the perfect combustion of the remaining carbon content compounds, an EQC, or the equivalent. And the pressure in the reaction section 25 (inside of a fission reactor 31), a gas stream, and temperature are set as the above mentioned conditions, the incomplete combustion of the carbon content compound used as a raw material is carried out, and fullerene is made to generate.

[0025] the manufacture approach of the fullerene which the manufacture approach of fullerene using the manufacturing installation 50 of this fullerene requires for the gestalt of operation of the 1st of this invention although the manufacturing installation 50 of the fullerene concerning the gestalt of operation of the 3rd of this invention is explained, and abbreviation -- since it is the same, explanation is omitted. The manufacturing installation 50 of the fullerene which starts the gestalt of operation of the 3rd of this invention as shown in drawing 3 is equipment which it is the fission reactor 55 equipped with the burner section 54 for combustion which has the carbon content compound feed hoppers 51 and 52 and the oxygen content gas supply opening 53, the carbon content compound and oxygen content gas used as a raw material are used, and a carbon content compound is burned (incomplete combustion), and manufactures fullerene. Hereafter, it explains in detail.

[0026] The fission reactor 55 bottom is equipped with the approximately cylindrical reaction section 56 which the upper part reduced the diameter of gradually and carried out opening. Piping (not shown) for passing to the downstream the fullerene generated in the reaction section 56 is connected to the upper limit of this reaction section 56. On the other hand, the lower limit of the reaction section 56 is equipped with a path slightly smaller than the reaction section 56, and the piping 57 for supplying oxygen content gas is attached in it in one. Moreover, after incorporating the piping 59 which branched from the piping 58 which supplies a carbon content compound to the interior of this piping 57 and branching this piping 59 further, the upper limit (downstream) of the branched piping 60 is attached in the lower limit of the reaction section 56 in one. In addition, the bulb 61 which enables adjustment of the amount of supply of the carbon content compound from each piping 60 respectively is attached in the downstream from the branch point of two or more piping 60 after branching.

[0027] And the carbon content compound feed hopper 51 for supplying a carbon content compound is formed in the height, for example, 1 / about four to 1/2 location, of the bottom flank 56 of the reaction section 56, i.e., the reaction section. As for this carbon content compound feed hopper 51, it is desirable that more than one are equiangularly prepared in the perimeter of the reaction section 56 to the axial center of the reaction section 56. Here, supply of a carbon content compound is enabled into the reaction section 56 by the piping 62 which branched from piping 58 being attached in the carbon content compound feed hopper 51. A bulb 63 is attached also in this piping 62, and adjustment of the amount of supply of a carbon content compound is enabled. In addition, two or more through tubes are prepared in the pars basilaris ossis occipitalis of the reaction section 56, and this through tube constitutes the carbon content compound feed hopper 52 and the oxygen content gas supply opening 53 at it. Here, it may be arbitrary, and plane view of the configuration of two or more of these through tubes may be carried out, and they may be circular, an ellipse form, a rectangle, a polygon, etc. and the indeterminate form of a gourd mold substantially. Moreover, although the arrangement location of a through tube is arbitrary, in order to pass a combustion style to homogeneity to the reaction section 56, the thing which were centered on the axial center of the reaction section 56 and for which it is regular intervals and two or more through tubes are arranged on the same or a concentric circle periphery is desirable. Under the present circumstances, even if the open end of a through tube is on the base of the reaction section 56, and an abbreviation same flat surface, you may project and the number of a through tube is arbitrary. Here, the burner section 54 for combustion also has above-mentioned piping 57-60 and above-mentioned piping 62.

[0028] Thus, in the burner section 54 for combustion, multistage (it sets in the gestalt of this operation and they are two steps) is equipped with the carbon content compound feed hoppers 51 and 52 to the flow direction of the elevated-temperature gas stream formed, i.e., the flow direction of oxygen content gas. Therefore, a carbon content compound can be gradually supplied from thin low equivalent ratio to oxygen content gas. In addition, although the case where a carbon content compound was supplied to multistage was explained by preparing a carbon content compound feed hopper in multistage, oxygen

content gas may be supplied to a single stage here by exchanging the feed hopper of a carbon content compound and oxygen content gas, and preparing oxygen content gas supply opening in multistage. The vacuum pump (not shown) which is an example of a vacuum means is connected to the above-mentioned reaction section 56, and the pressure in the reaction section 56 is made under into atmospheric pressure at it.

[0029] As mentioned above, although this invention has been explained with reference to the gestalt of operation, this invention is not limited to a configuration given in the gestalt of operation described above in any way, and also includes the gestalt and modification of other operations which are considered within the limits of the matter indicated by the claim. For example, in the gestalt of said operation, the case where it had a carbon content compound feed hopper or two steps of oxygen content gas supply openings to the flow direction of the gas of the elevated-temperature gas stream formed, respectively was explained. However, it is also possible to have a carbon content compound feed hopper or three or more steps of oxygen content gas supply openings, and it is also still more possible to have a carbon content compound feed hopper and two or more steps of oxygen content gas supply openings, respectively. Moreover, it is also possible to arrange a carbon content compound feed hopper and/or oxygen content gas supply opening in the location of arbitration, and to prepare for multistage.

[0030] Moreover, in the gestalt of said 1st [the] and the 2nd operation, the case where the one burner section for combustion prepared in the fission reactor bottom was attached was explained. However, it is also possible to prepare two or more burner sections for combustion in the fission reactor bottom. In this case, at the pars basilaris ossis occipitalis of the reaction section, it is desirable to form opening in the location corresponding to the anchoring part of the burner section for combustion, respectively. Thereby, a rapid cubical expansion at the time of combustion with a carbon content compound and oxygen content gas can be controlled further. And in the gestalt of said operation, although a carbon content compound explains combustion, for example, when incomplete combustion was carried out and fullerene is made to generate, even when perfect combustion is carried out, fullerene may generate.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the explanatory view of the manufacturing installation of the fullerene concerning the gestalt of operation of the 1st of this invention.
[Drawing 2] It is the explanatory view of the manufacturing installation of the fullerene concerning the gestalt of operation of the 2nd of this invention.
[Drawing 3] It is the explanatory view of the manufacturing installation of the fullerene concerning the gestalt of operation of the 3rd of this invention.
[Description of Notations]
11 The manufacturing installation of fullerene, 12 : 10: A carbon content compound feed hopper, 13: Oxygen content gas supply opening, the burner section for 14:combustion, 15 : A fission reactor, 16 : Casing, 17-19:piping, 20, 21:bulb, 22:adiabatic wall, 23 : A stabilizer, 24:pilot burner, 25:reaction sections, 26 : Opening, the manufacturing installation of 30:fullerene, 31:fission reactor, 32:carbon content compound feed hopper, 33, 34:oxygen content gas supply opening, the burner section for 35:combustion, 36 : Casing, 37 : A through tube, 38:lobe, 39:piping, 40:separation wall, 41:separation board, 42: -- opening, 43:through tube, and 50: -- the manufacturing installation of fullerene, 51, 52:carbon content compound feed hopper, 53:oxygen content gas supply opening, the burner section for 54:combustion, 55:fission reactor, and 56: -- the reaction section, 57-60:piping, 61:bulb, 62:piping, and 63:bulb

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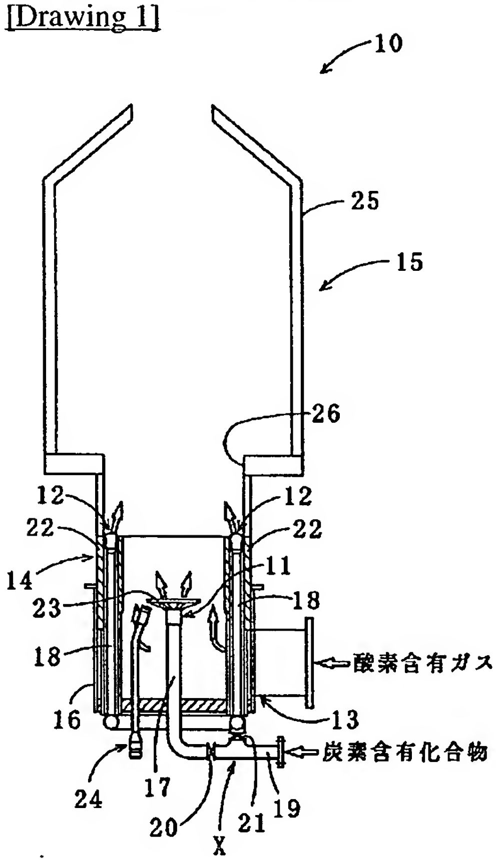
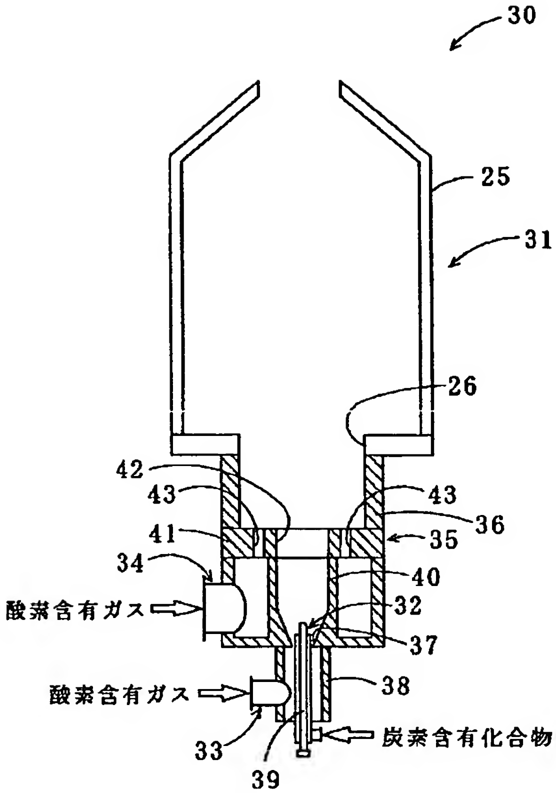
DRAWINGS

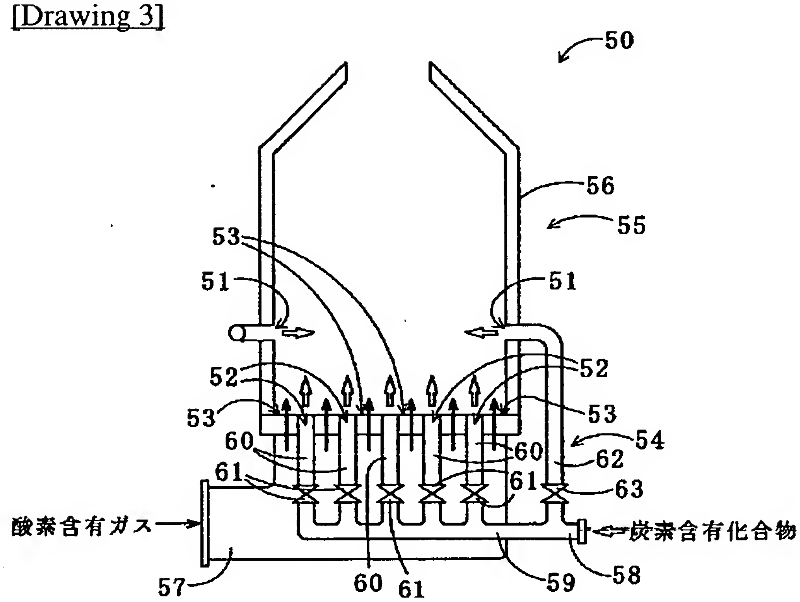
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]